Technip UK Limited

Report

Aberdeen Offshore Wind Farm Ornithological Baseline and Impact Assessment Addendum

June 12

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Aberdeen Wind Farm Ornithological Baseline and Impact Assessment Addendum

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PREFACE

On 1st August 2011 Aberdeen Offshore Wind Farm Limited (AOWFL) applied to the Scottish Ministers under Section 36 of the Electricity Act 1989 (as amended), and applied for a Marine Licence under the Marine (Scotland) Act 2010 to construct, operate and decommission an offshore wind farm and deployment centre off the coast of Aberdeen, Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre (EOWDC).

The application comprised an Environmental Statement (ES), prepared in accordance with the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 (as amended) and Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended) and followed current best practice.

The August 2011 submission comprises the following volumes:

Volume 1 – Non-Technical Summary

Volume 2 – Environmental Statement

Volume 3 – Figures

Volume 4 – Technical Appendices

<u>Project Description / Rochdale Envelope</u>

When the ES was submitted to Marine Scotland in August 2011, it had been agreed that further information would be required in support of the application. This further information was referred to as an 'Addendum' to the ES.

An application for an Offshore Wind Farm requires some flexibility to enable subsequent detailed design. This is particularly important in the context of the scheme to be developed as a demonstrator site. In order to carry out an environmental assessment of the project, parameters require to be defined and sufficient information provided to enable the identification of the significant effects. These parameters form the Rochdale Envelope.

At the time of defining the Rochdale Envelope (as submitted August 2011) the project engineers undertook consultation with the supply chain to understand their ambitions and likely details of their future wind turbines that were at an early stage of development. The results of this initial consultation were inevitably a reflection of the supply chain at the time, and the stated ambitions of manufacturers at the time.

In keeping with the concept of a demonstrator site, over recent months, AOWFL has engaged with global turbine suppliers who wish to demonstrate their next generation turbine technology at the AOWF site. AOWFL has commenced a formal commercial process to identify and refine the turbine supply options for the site. This process is at an early and confidential stage, however revised turbine specifications have been made available to the project by the manufacturers.

The overarching objective of the EU grant associated with AOWF, is to deploy new equipment, systems, processes and initiate R&D to improve the competitiveness of offshore wind energy production, whilst generating environmentally sound marketable electricity and to increase the supply chain capabilities in Scotland, the wider UK and Europe.

The commercial evaluation of prospective turbine suppliers who can meet the EU requirements has revealed that a number of manufacturer's turbines marginally exceed the Rochdale Envelope parameters (as submitted). These turbines would require an adjustment to the tip height of up to 198.5m, and rotor radius of up to 86m as summarised in the table below.

Please note that the maximum dimensions are likely only to be applicable to specific wind turbine locations and are unlikely to be relevant to all 11 turbine locations. Please also note that a minimum clearance of 22m above Mean High Water Springs (MHWS) will be maintained for marine navigation.

Table 1: As submitted Rochdale Envelope and proposed adjusted Rochdale Envelope

Parameter	Rochdale Envelope as submitted	Rochdale envelope (as requested)	Differential
Tip Ht (aLAT)	Up to 195 m	Up to 198.5 m	3.5 m
Hub Ht (aLAT)	Up to 120 m	Up to 120 m	Nil (likely reduction)
Rotor radius (diameter)	Up to 75 m (150 m)	Up to 86 m (172 m)	11 m (22 m)

Environmental Statement Addendum (June 2012)

Addenda are commonly submitted as a project evolves through time to clarify issues, or to provide additional baseline data and updated environmental assessment information. This report (Ornithological Baseline and Impact Assessment Addendum) forms part of the ES Addendum.

The June 2012 Addendum contains the following information:

- Additional bird and marine mammal baseline data.
- An additional visualisation from Girdleness lighthouse.
- Results of a geo-locational study into golf courses and Round 1 offshore wind farms.
- Requested minor adjustments to turbine dimensions, which form a part of the project description information, known as the ‘Rochdale Envelope’.
- Supporting statement and representative viewpoints of landscape and visual effects taking account of the adjustments to the Rochdale Envelope and preliminary design principles.
- Updated ornithological collision risk modelling resulting from the updated Rochdale Envelope, updated ornithological impact assessment, and updated Habitats Regulations Assessment.

Where to View the Consent Application

The ES addendum submission may be viewed at the following locations during normal office hours:

Vattenfall Wind Power Ltd 3rd Floor The Tun Holyrood Edinburgh EH8 8AE	Balmedie Library Eigie Rd Balmedie AB23 8YF
Aberdeen Central Library Rosemount Viaduct Aberdeen AB25 1GW	Peterhead Library 51 St Peter Street Peterhead AB42 1QD
Ellon Library Station Road Ellon AB41 9AE	Bridge Of Don Library Scotstown Road Bridge Of Don Aberdeen AB22 8HH

The ES addendum can also be viewed at the Scottish Government Library at Victoria Quay, Edinburgh, EH6 6QQ.

OBTAINING YOUR OWN COPY OF THE ES ADDENDUM

The ES addendum is available on the Vattenfall website:

http://www.vattenfall.co.uk/en/aberdeen-bay.htm

1.1.1 Contents

NON TECHNICAL SUMMARY

This report presents the results from baseline ornithological surveys undertaken in order to inform the Environmental Impact Assessment (EIA) prepared for the proposed Aberdeen Offshore Wind Farm (AOWF) also known as the European Offshore Wind Deployment Centre (EOWDC) and the findings of the impact assessment undertaken.

The proposed EOWDC development lies to the north of Aberdeen. The proposed development comprises of the potential installation of 11 wind turbines and a potential future option of an ocean laboratory, which would be subject to a separate application. The EOWDC is a test centre for wind turbine technology and therefore the potential structures of the wind turbines that could be installed are currently unknown. In order to take these uncertainties into account a worst-case scenario has been applied when assessing the potential impacts.

Prior to undertaking any assessment a variety of bird surveys have been commissioned since 2005 aimed at identifying the potential bird sensitivities that may occur within Aberdeen Bay throughout the year. The surveys comprised of monthly boat-based bird surveys undertaken between February 2007 and April 2008 and again from August 2010 to August 2011. On-going boat-based surveys have been undertaken from August 2011 to May 2012 but the data have not been analysed for use in this assessment. Due to the proximity of the proposed development to land, vantage point surveys have been undertaken on a monthly basis for a period of three years between March 2005 and October 2005 and April 2006 to March 2008. The surveys complimented those undertaken by boat and provide data on birds present in nearshore waters of Aberdeen Bay. (Based on advice from SNH data from the surveys undertaken in 2005 have not been used in this assessment.) In addition to the boat-based and vantage point surveys, three studies using radar have been commissioned: in October 2005, April 2007 and April 2010. These radar studies provided information on the use of Aberdeen Bay over a wider area and during periods of darkness and/or poor visibility.

The data from all the surveys have been used to help inform the impact assessment.

The impact assessment has considered all species of bird recorded from all surveys undertaken in Aberdeen Bay. It has also considered other sources of published data, e.g. North-east Scotland Bird Reports, JNCC aerial surveys (Söhle *et al.* 2006; Lewis *et al*. 2008) and the Birds of North-east Scotland (Buckland, Bell and Picozzi 1990) and the Breeding Birds of North-east Scotland (Francis and Cook 2011).

The potential impacts on all relevant bird species that were identified as qualifying species for coastal Special Protected Areas (SPA) from Shetland to the Firth of Forth have been assessed within the impact assessment. Other species which were recorded in significant numbers and had the potential to be impacted by the proposed EOWDC have also been addressed within the main impact assessment, Section 4.0. All other species that occurred in low numbers for which it was determined that there is unlikely to be a significant effect based on the data collected and relevant published documents have been summarised at the end of the report.

For the purposes of this impact assessment an evidence based approach has been used to determine potential impacts as well as expert judgement based on the baseline information and results from other offshore wind farms. An impact matrix has been used to provide a structure and consistency of approach and has been used as tool to help inform the impact assessment (SNH 2009). However, the impact matrices have not been considered to be definitive, nor in isolation. The assessment of potential impacts is ultimately based on the latest published data available, i.e.

wherever possible an evidence based approach has been adopted and judgements made.

The impact assessment recognises that under the EIA Regulations, significance is used to determine the relative importance of an effect on a feature, whereas under the Habitats Regulations it is a coarse filter to determine whether a further Appropriate Assessment is required (IEEM 2010). The level of significance is based on the sensitivity of the species to a particular impact and the potential magnitude of the effect on that species. The duration of the potential impact is also recognised.

Potential impacts identified are:

Collision Risk

Collision risk modelling has been undertaken based upon the Band *et al.* (2011) model and presented in Appendix A. The approach to collision risk modelling was presented and agreed with SNH and RSPB in February 2012.

For the purposes of this assessment a range of avoidance rates have been considered to give a range of potential mortality rates. The avoidance rates used are 95%, 98%, 99% and 99.5% based on SNH guidance (SNH 2010a). However, in order to determine potential effects a precautionary 98% has been used in the first instance, unless there is evidence that the use of a higher or lower avoidance rate may be more appropriate.

Not all species recorded within Aberdeen Bay are at significant risk of collision. The level of risk depends on a large extent as to whether the species frequently flies at rotor height. Birds can fly at any height and may change depending upon weather conditions or behaviour. However, by using data from both site specific boat-based survey data and other extensive data sets from other offshore wind farms a large sample size of flight heights are available for collision risk assessment. These have recently been compiled and a model developed to assess flight heights using an extensive data set from a wide range of offshore wind farms (Cook *et al.* 2012).

Collision risk modelling has been undertaken based on site specific data and the results from Cook *et al*. model and results from both sets of modelling are presented. The results from the Cook *et al.* (2012) model are based on a minimum turbine height of 20 m and therefore are within the minimum Rochdale envelope height.

The results from the collision risk modelling use the additional data collected up to January 2012 and is presented using both the original and revised Rochdale envelope and across a range of avoidance rates using both site specific and generic flight heights. In the first instance the worst case, i.e. the highest number of collisions predicted from either the site specific or generic flight heights is assessed based on the revised Rochdale envelope and a 98% avoidance rate.

Species selected for collision risk modelling have been selected on their frequency of flying at rotor height and the frequency at which they are recorded in Aberdeen Bay.

Collision risk modelling was undertaken on the following species:

- Common scoter
- Eider
- Red-throated diver
- Pink-footed goose
- Barnacle goose
- Fulmar
- Gannet
- Cormorant
- Shag
- Herring gull
- Great black-backed gull
- Kittiwake
- Sandwich tern
- Common tern
- Arctic skua
- Guillemot
- Razorbill
- Puffin

- Common gull

Barrier effect

Barrier effects may arise should the species avoid flying through the proposed development and by doing so incur additional energetic costs required to fly the extra distance around the turbines (Speakman, Gray and Furness 2009; Masden *et al.* 2010). The risk of an impact is largely dependent on the number of times a bird may have to cross the obstruction and also the individuals' fitness. Should a bird be required to avoid an area only once or twice a year when undertaking a migration then it is likely that the potential impact will be lower than if a bird regularly flies around a barrier, e.g. between a feeding or roosting site (Speakman, Gray and Furness 2009).

In order to assess the potential impacts from displacement it is assumed that, unless data from other wind farms indicated otherwise, all individuals avoid flying through the site and detour around it and by doing so fly further than would have otherwise been the case. To calculate the potential length of a detour it is assumed that the detour started 1 km in front of the proposed development and that the bird detoured back on to the original course 1 km beyond the proposed development. Where appropriate, results from energetics modelling have been considered to assess the potential incremental increase in daily energy expenditure (Speakman, Gray and Furness 2009).

Displacement

Disturbance caused by the proposed EOWDC may lead to displacement of birds from potential feeding areas, resulting in effective habitat loss. Displacement may be caused by disturbance from vessels associated with the proposed development or from secondary impacts, i.e. the depletion of prey in the development area. The significance of the displacement is difficult to quantify but for species that rely on localised or patchy food supplies the effect may be more significant than it is for species that have a wide area of food supply. Based on the Maclean *et al.* (2009) and Furness and Wade (2012) reports, the impact assessment has considered sensitivity of a species depending on its habitat flexibility, i.e. how restricted is the species to a particular habitat preference.

Significance of impact

The potential significance of the impact is based on the possible magnitude of an effect occurring and the overall sensitivity of each species to the impact. The results indicate the likely significance any impact may have on the receptor. However, this is only an indicative sensitivity and evidence from existing wind farms and expert judgement is used to determine whether the potential impact was likely to be either significant or adverse (IEEM 2009).

Where the potential significance is identified as being negligible or minor, the effect will not be significant. A finding of moderate significance has the potential to be either significant or not significant. A moderate finding will be subject to a further detailed review to determine whether or not the effect would be significant in terms of the Regulations or not. A finding of major significance will result in a significant effect in terms of the Regulations.

It should be noted that the significance derived at is only a guide and the final conclusions of the impact assessment for each species is drawn upon the currently available evidence for each species.

Determining potential adverse effects

The Habitats and Birds Directives require an assessment to be undertaken to determine whether there are any potential adverse effects on a species. In order to do this the impact assessment has identified all the relevant SPAs for which there may be an interaction with the qualifying species and the proposed development. The assessment to ascertain whether there is an adverse effect on site integrity is a judgement, based on the best available evidence.

Assessment of cumulative impacts

The cumulative impact assessment considers all other industries which have the potential to impact on the birds that may be present at the proposed development location, these include:

- Offshore renewables,
- Shipping,
- Aggregates,
- Dredging,
- Oil and gas,
- Recreational activities,
- Fishing.

Offshore renewable projects that have been identified as having the potential for a cumulative effect include two developments in the Moray Firth and three in the Firth of Forth. The sites in the Moray Firth are approximately 150 km to the north and those in the Firth of Forth approximately 120 km to the south of the proposed development.

The construction of the proposed EOWDC may overlap with construction activities being undertaken at other planned developments. However, given the stage of development of the renewable projects yet to be constructed and the uncertainty as to the types of foundations and turbines that will be used, there is sparse information available to incorporate into any impact assessment, which limits the effectiveness of cumulative assessments considering conceptual projects yet to be subject to a formal planning application and for which no environmental or design data are currently available.

Therefore, the cumulative impact assessment can only be undertaken with data available from the currently operating Beatrice demonstrator project in the Moray Firth and the recent application for the Beatrice Offshore Wind Farm (BOWL 2012). The assessment does wherever possible consider potential cumulative impacts from other renewable projects for which no applications have been made.

Shipping activities within Aberdeen Bay are described and assessed in Chapter 27 of the Environmental Statement (as submitted in August 2011). Shipping associated with the harbour has been undertaken in Aberdeen Bay over many centuries with currently approximately 16,000 vessel movements per year. There are no known plans that are likely to cause a significant increase in the level of shipping currently being undertaken in Aberdeen Bay and any impacts shipping may currently be having on the birds within Aberdeen Bay will be part of the baseline. The majority of vessel movements are to the east of the proposed development and therefore unlikely to cumulatively impact on nearshore birds, particularly Divers and Seaduck.

There are no aggregates activities within Aberdeen Bay. There are no licensed dredging sites within Aberdeen Bay but occasional dredging of the harbour may occur.

Aside from associated shipping there are no oil and gas related activities within Aberdeen Bay.

Recreational activities within Aberdeen Bay are described in Chapter 23 of the Environmental Statement (as submitted in August 2011). The main potential for a cumulative impact is considered to arise mainly from yachting with many recreational vessels following an inshore route from the Forth to Peterhead and vice versa, often at night to take advantage of favourable tidal flows. The numbers of recreational vessels using Aberdeen Bay are unknown. However, the level of impact caused by recreational activities has been on-going for many years and the disturbance that this may cause to birds in Aberdeen Bay is part of the baseline environment. It is predicted that the presence of the EOWDC will not cause any greater level of recreational activity in Aberdeen Bay than is already present and although the scale of the activity is unquantified the presence of the proposed development will not likely cause a significant increase in vessels detouring into nearshore waters to a level that could cause a significant impact on the birds present. No cumulative impacts are predicted to occur over and above the current levels of disturbance.

Fishing activity within Aberdeen Bay is described in Chapter 21 of the Environmental Statement (as submitted in August 2011). The level of fishing activity within the bay is relatively low and few vessels occur within the area of the proposed development. The presence of the proposed EOWDC is not predicted to increase the level of fishing activity in the area and consequently the cumulative impact from fishing will be no greater than the current levels of impact, which are part of the baseline conditions.

Assessment of in-combination impacts

The Conservation (Natural Habitats, and c.) Regulations 1994 (as amended) require that a Habitats Regulations Appraisal (HRA) must be conducted by a competent authority. The HRA considers the implications for European sites in view of the European sites conservation objectives, in respect of any plan or project which is not directly connected with or necessary to the management of the European site for conservation purposes and which is likely to have a significant effect on the European site either alone or *in-combination* with other plans or projects.

Therefore the term 'in-combination' will be used when considering the impacts of the proposals with other plans or projects on European sites.

The main industries considered for potential in-combination impacts are proposed offshore wind farms, aggregate industry, dredging, oil and gas, shipping, recreational activities and fishing. Of these, proposed offshore wind farms and shipping are the only activities identified for which there is a potential for an in-combination impact.

Results

Data from boat based surveys indicate that the use of the proposed development area is relatively lower for most species, with generally higher densities of birds recorded to the north and south of the site.

For most species the results of the assessment identify that the proposed development will only to have a negligible or a minor effect on the species present.

However, the impact assessment has identified the potential for impacts of moderate significance on red-throated diver.

Red-throated diver may be displaced from the area of the proposed development during construction, operation and decommissioning phases. Site specific data indicate that although the higher numbers of red-throated diver occur to the north of the proposed development area a proportion of the local regional population may be displaced. The effects of the possible displacement on red-throated divers are unknown but could be significant were all those displaced not to survive. However, this scenario is considered improbable as the red-throated diver is not resident in Aberdeen Bay and the proposed development is in an area not favoured by red-throated diver. Any Divers that may be displaced will be able to move to other suitable foraging areas. Therefore, although the impact may be moderate in terms of displacement the actual impact on the Diver population within Aberdeen Bay will be negligible or minor.

Mitigation and Monitoring

Detailed mitigation and monitoring measures aimed to avoid, remove or reduce any potentially significant impacts will be developed more fully during consultation with the Regulator and their statutory advisors and other stakeholders.

The main potential impacts arising from the proposed development relate primarily to direct or indirect displacement effects on Divers. However, other minor impacts on other species, e.g. seaduck, Terns and Gulls have also been identified. Measures that may be considered as inbuilt mitigation to help avoid, remove or reduce impacts include:

- Minimising the proposed development area as far as practicable in the early design stage,
- Vessel management plans to ensure vessels minimise disturbance as far as practicable,
- Installing foundation types that reduce noise levels during construction.
- Timing and duration of installation,
- Minimising, as far as practicable, aviation and navigation lighting.

Detailed discussions with the competent authorities and their advisors will further develop potential effective mitigation.

It is important that monitoring is undertaken that is designed to address specific concerns or potential impacts identified during the EIA process. Poorly designed *ad hoc* monitoring is likely to be inefficient and not provide useful or meaningful results. It is therefore important that a detailed monitoring programme is developed in collaboration with the Regulator and statutory advisors and taking note of key stakeholders comments during the consultation period.

The proposed EOWDC aims to encourage and enable environmental monitoring through research and development. The research and monitoring will seek to answer outstanding questions on environmental impacts from offshore wind, including those on birds.

In order to facilitate the delivery of research a steering group will be formed and managed by an R&D manager. Specialist working groups will provide the detailed technical competences supporting the R&D.

Future research and monitoring will be agreed through the R&D working group but potential monitoring and research includes:

- Collision risk studies on birds;
- Tagging and tracking studies of seabirds to and from breeding colonies and outwith the breeding season to look at barrier effects;
- Specific studies aimed at determining potential changes in bird distribution, i.e. displacement or attractant effects;
- Studies looking at potential secondary impacts on prey species, e.g. changes in prey fish and benthic distributions.

Further discussions will help develop these and other ideas into meaningful projects from which useful results will be obtained.

1.0 INTRODUCTION

This technical appendix has been prepared to accompany the Environmental Statement in support of the consent applications to construct, operate and decommission the proposed Aberdeen Offshore Wind Farm (also known as the European Offshore Wind Deployment Centre (EOWDC)).

This technical appendix provides a summary of the results from site specific ornithological surveys undertaken in Aberdeen Bay in support of the proposed development between 2005 and 2011. Based on the site specific data and other existing published studies an environmental impact assessment of the potential impacts on birds occurring in Aberdeen Bay is presented on a species by species basis.

This technical appendix comprises of:

- Non Technical Summary,
- Bird Survey Methods,
- Impact Assessment,
- Species Assessment,
- Summary,
- Mitigation and Monitoring,
- Collision Risk Modelling Appendices.

The findings of the technical appendix are summarised in Chapter 10 of the Environmental Statement.

2.0 BIRD SURVEY METHODS

2.1 Introduction

Three different types of bird surveys have been undertaken since 2005 in order to obtain suitable ornithological survey data to inform the Environmental Impact Assessment and, if required, Habitat Regulations Appraisals.

Monthly boat-based surveys were undertaken over a period of two years and in two phases. Year 1 surveys were undertaken between February 2007 and April 2008 and Year 2 surveys between August 2010 and August 2011. Data from these surveys have been used in the impact assessment. Further boat-based surveys were undertaken from August 2011 and May 2012. Data from these additional surveys were not available for inclusion within the assessment and, with the exception of selected months required to support the collision risk modelling, have not been used in this addendum. In addition to the Boat-based surveys, two years of vantage point surveys undertaken between April 2006 and March 2008 and three radar surveys were carried out in October 2005, April 2006 and April 2010 (Figure 2-1).

The results from these surveys along with additional information have been used to help inform the Environmental Impact Assessment.

Boat-based Survey Methodology and Data Analysis

Survey Area and Transects Route

There have been two periods of boat-based bird surveys undertaken in support of the proposed development.

Between February 2007 and April 2008 boat-based surveys were undertaken on a monthly basis. Each survey covered an area of 101.6 km^2, which included the then proposed development site plus a buffer zone and a 'control' survey area located immediately to the north (Figure 2-2). The 'control' survey area of 50.8 km^2 was the same size as the then proposed EOWDC site (including the buffer zone). The site proposed at the time the surveys were being undertaken represented 12% of the total area surveyed, and 24% of the proposed EOWDC survey area. The distance of the shoreline to the proposed EOWDC survey area varied between 0.6 km and 7 km and to the 'control' survey area between 0.5 km and 6 km. The 'control' survey area was positioned in an area exhibiting similar physical attributes (bathymetry and seabed type) to that of the development site survey area (IECS 2008).

Various transect designs were considered when establishing the survey methodology (e.g. parallel to the coast, perpendicular and zigzag). At the time it was considered that a perpendicular alignment provided the best option in terms of data collection and analysis, as it best captured environmental factors such as depth and wave exposure. As such, the sampling design comprised a grid of systematically spaced line transects approximately perpendicular to the coast. The transects, spaced 1 km apart, were conducted perpendicular to the coast on an approximately east-west orientation (Figure 2-2).

The 'control' and development areas each consisted of 10 main transects 6.5 km long, together with nine short legs 1 km long, and therefore constituted two separate samples. The 20 transects were travelled over two days, preferably on two consecutive days (with 10 transects per day). The transects were steamed at a constant speed of approximately 8 knots. The survey route was designed to give a total boat transect length of 74 km per site, considered to be approximately the maximum length of transect which can be covered in daylight hours during the winter at this location.

The 'short legs', which preserved the spacing of 1 km between the main transects, were surveyed to gather additional data. The shoreward side was always covered in both the inshore and offshore short legs. To ensure coverage of the shallow areas, it was necessary to operate the 300 m band transect on the port side when commencing from the south end of the site, and on the starboard side when starting from the north end of the site. The four start points for the 'control' and proposed EOWDC survey areas were randomised between the surveys. The transect band on the main transects were operated alternatively on the port and starboard sides to avoid the sun glare.

In order to reduce disturbance to birds (and marine mammals) prior to and after surveying, the survey vessel did not travel through the survey area when positioning or returning from the northernmost extent of the site. Instead, the boat followed an offshore route outside the survey area.

Following the completion of the Year 1 bird surveys, the location and size of the proposed development was amended. This meant that, although the previous surveys did cover the revised location for the proposed development (Figure 2-3), to ensure better potential for future monitoring an alternative survey area was designed for the boat-based bird surveys undertaken for Year 2 data collected between August 2010 and August 2011 (Figure 2-4).

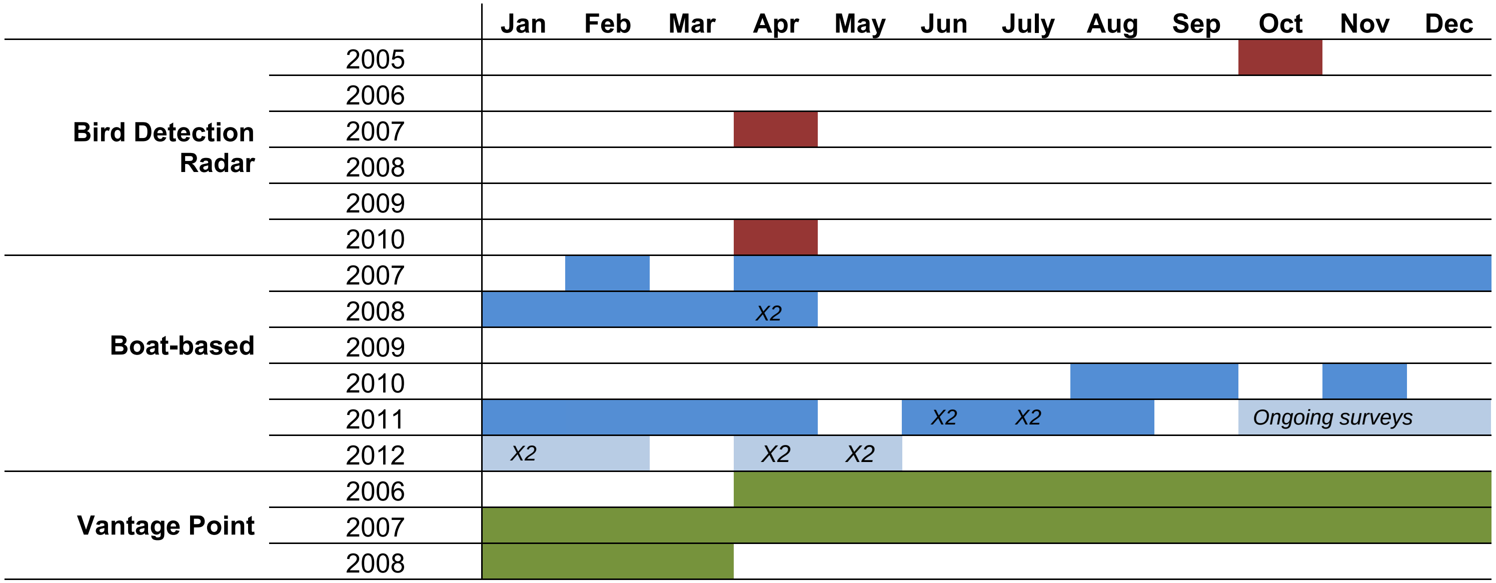
In addition to the differing survey area due to the revised location of the proposed development, the survey design was also amended to take into account advances in understanding of the limitations in using Before After Control Impact (BACI) designs. The use of the gradient approach allows distance from the development footprint to be included as a covariate within the analysis. Consequently, it improves the future potential to detect change in seabird distributions and abundances. Three areas were surveyed each month to the north, south and east outwards to 25 km allowing a gradient approach to be used (SMRU 2011b). The total surveyed area each month was 339 km^2, comprising of three strata: 150.8 km^2 (north), 82.8 km^2 (south) and 105.2 km^2 (offshore) (Figure 2-4).

The surveys undertaken since August 2010 have also been undertaken in equally spaced zigzag line transect as opposed to linear parallel surveys as previously undertaken. By doing so this allows continuous surveying and less time wasted in transit between parallel transects. It also provides coverage of the full depth, distance to shore and wave exposure gradients present. The survey design was carried out using the Distance software to ensure even coverage probability within each stratum.

The start point of transects routes was randomised to account for any confounding effects of time of day and port activity e.g. bird activity may decline from a morning peak and port activity increase.

Total number of birds recorded in each month in each year from boat-based surveys are presented in Table 3-2 and Table 3-3.

Figure 2-1: Survey periods



= ongoing surveys for future analysis. Data not available for use in ES

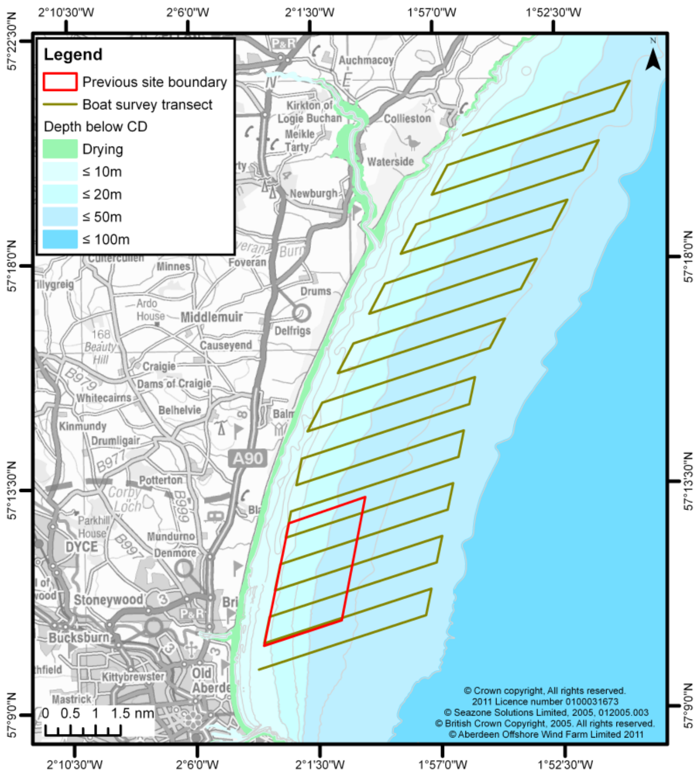


Figure 2-2: Areas surveyed from boats for birds and marine mammals between February 2007 and March 2008 and the proposed EOWDC location at the time surveys were undertaken.

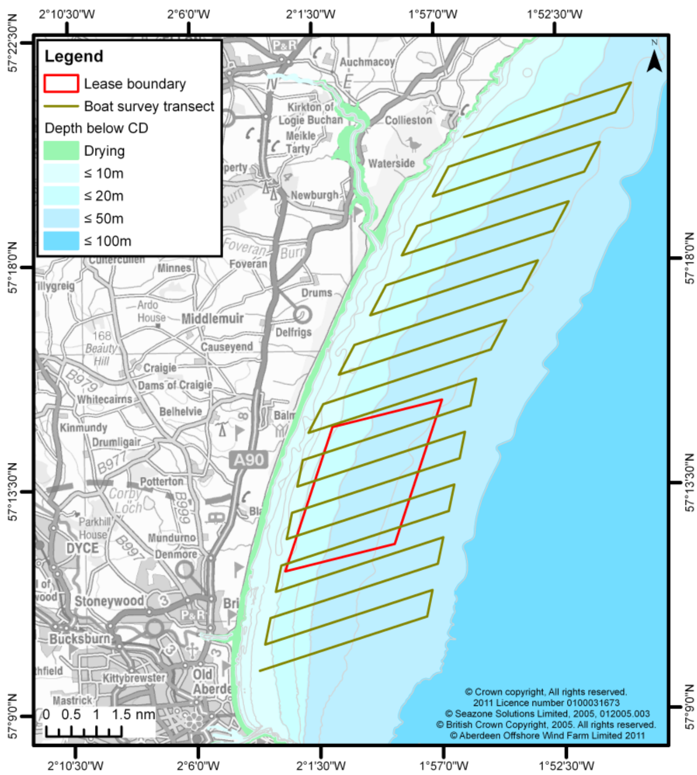


Figure 2-3: Areas surveyed from boats for birds and marine mammals between February 2007 and March 2008 and the revised EOWDC location.

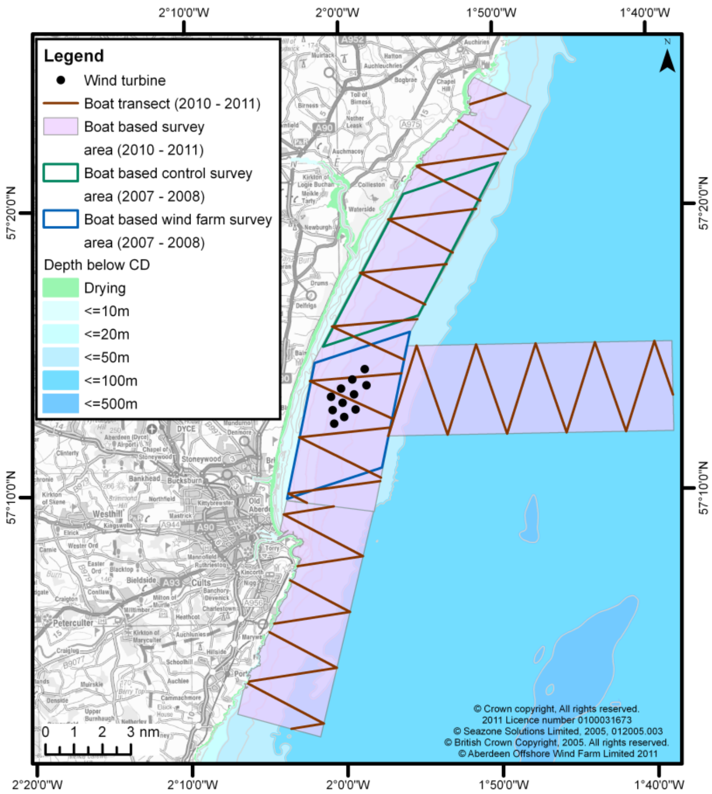


Figure 2-4: Survey strata and transects in the context of previous areas surveyed and the approximate area of the development site for surveys undertaken between August 2010 and August 2011.

Survey Programme

Between February 2007 and March 2008 and August 2010 to August 2011, surveys were conducted once every month during daylight hours and efforts were made to undertake the survey over two consecutive days. Due to issues arising outwith the control of the project no surveys were undertaken during October 2011, December 2011 and May 2011. However, double the numbers of surveys were undertaken in periods of potentially higher sensitivity in June and July 2011. Surveys were primarily conducted in conditions of less than sea state 3 with consideration given to residual swell levels prior to the surveys being undertaken. The times of the surveys were dependent on the weather conditions, availability of the survey boat and of the observers. However, the survey programme was scheduled to cover different tidal states and times of the day (where possible during the longer hours of daylight in the summer) in order to get an adequate coverage of the factors that may affect the distribution, abundance and activities of birds and marine mammals in the Aberdeen Bay area.

Boat-based surveys were conducted in February 2008 to coincide with the vantage point (VP) watches (See Section 2.2) with shore-based observations undertaken by an experienced bird/marine mammal observer, to monitor any potential disturbance of birds and marine mammals by the survey vessel.

Sampling Methods

Both boat-based survey programmes employed the standard seabird census techniques for use on a boat platform as described by Camphuysen *et al.* (2003). The methods involved a band transect, operated on one side and ahead of the ship, and with short time-intervals in a continuous series, to sample short stretches of water with a known surface area and location.

All surveys were undertaken by a team of three experienced observers who had been Joint Nature Conservation Committee (JNCC) European Seabirds at Sea (ESAS) trained and included observers who had completed the JNCC's Seabirds at Sea Team (SAST) training course for seabird surveyors (Edinburgh 2005 and 2006), and had experience of surveying seabird populations including numerous ship-based seabird surveys.

Observers undertook a 90º scan with a 300 m band transect using a snapshot technique. The 300 m strip on one side of the ship with the best visibility (least glare etc.) was divided into a series of distance bands running perpendicular to the ship (using the Camphuysen *et al.* 2003 divisions).

Birds observed within the band (A-D) were noted as being '*in transect'*. Flying birds were recorded '*in transect'* using the *snapshot technique* to overcome biases caused by the flux of flying birds. Bird data were summarised on field data forms every minute using a snapshot at a speed of 8 kts (frequency of snapshot could be adjusted according to the speed of the boat). A recording interval of 1 minute was considered to be most applicable for such a relatively small area and coastal location, subsequently allowing a more detailed analysis of species distribution.

Two observers were present on the observation deck counting birds simultaneously. The role of the primary observer was to detect by naked eye, birds on the sea (within transect) and in the air through an arc of 90º. The secondary observer recorded observations and assisted the primary observer in the detection of birds by naked eye. The third observer was dedicated to the forward detection of divers and seaducks, which are known to flush from the sea surface at considerable distance from the vessel. In contrast to the first two observers, detection of birds by the third observer was made by continuous forward scanning using high quality binoculars in order to improve the detection of escaping and diving birds. Each bird was only recorded once, and 'ship associates' were ignored. The third observer assisted the main team of two observers during the spring migration (March, April and May) and autumn migration (September and October) when it was thought that potentially large movements of divers, seaducks and auks might occur during these periods. All three surveyors alternated roles during surveys to reduce observer fatigue and standardise findings.

Distance and band estimates of Observers were checked during surveys to ensure consistency across transects and observers.

In addition to the parameters required by the ESAS methodology, extra information was recorded by the observers in order to assess the potential problems of double counting and bird disturbance (particularly to Divers and seaducks) created by the survey vessel. The extra information included the behavioural response from the approaching vessel (e.g. escaped/dived or flushed) and the distance at which the birds responded.

For each observation the details shown in Table 2-1 were recorded.

Table 2-1: Biological variables collected by bird surveyors and order of recording priority.

1	Species	Identification to species level. However, this is not always possible and in this case the most precise identification possible should be given e.g. common guillemot/razorbill, large gull sp. (great black-backed gull/lesser black-backed gull and herring gull).
2	Numbers	Number of individuals present within the sighting.
3	Transect	A tick placed in a column of the recording sheet if the bird is '*in transect*'. A blank is left if the bird is not '*in transect*'.
4	Behaviour	On the water or flying.
5	Distance from the ship	Distances of the bird from ship are estimated using a range finder, and coded as follows. For birds on the water the SAST sub-divide the 300 m band transect into four zones. A: 0-50 m, B: 50-100 m, C: 100-200 m, D: 200-300 m and E> 300 m. For flying birds; 1: 0-100 m, 2: 100-1,000 m and 3: > 1,000 m.
6	Flight height	The distribution of flying height is estimated and assessed from the ship, by categorising any birds seen in flight to its altitude. Categories are expressed as 0-2 m, 2-10 m, 10-15 m, 15-25 m, 25-50 m, 50-100 m, 100-200 m, >200 m to avoid confusion. Flight height categories follow the COWRIE guidelines.
7	Direction	Flight direction of each sighting is recorded.
8	Behavioural response to survey vessel	Flushed to flight (F) or diving in response to survey vessel (E/D).
9	Distance of response	Distances of the bird flushed to flight or diving from the ship estimated in metres.
10	Plumage, moult, age and sex of the bird	Where age is unknown, a blank is left otherwise coded as follows: A: Adult and IMM: Immature. For plumage, S: summer and W: winter is used.
11	Cetaceans	Cetacean and sea mammal sightings recorded where appropriate.

Additional environmental data in the form of a survey log was maintained during the surveys, with data collated including weather conditions and sea state, as well as additional observations such as positions of fishing boats and other vessels, with observational data on species logged on modified SAST recording sheets. Prior to the survey programme commencing, all transect start and finish points were inputted into the ship's GPS system, and subsequent transects were then steamed using these co-ordinates. Survey logging of transects was determined using a handheld GPS. Output from the GPS provided the position (in latitude and longitude), speed, and bearing of the boat for every time interval recorded.

Boat-based Surveys Data Treatment and Analysis

Estimating population size in the ship-based survey areas

Total population size within an area surveyed was estimated using a variety of methods, including:

- Extrapolation of density
- Distance sampling; and
- Summed interpolated (kriged) abundances derived from geostatistical analyses

The effectiveness of the methods for producing accurate total population size estimates is discussed in McSorley *et al.* (2005). Distance sampling is a widely applied method of estimating total numbers and is currently the only method that allows estimation of 95 confidence limits. This method, using the *Distance* computer programme, is used as a primary method of estimating population size for the most frequently recorded species in this report. However, *Distance* may not produce accurate results where the numbers of observations are very small; where this is the case, use of an alternative method is necessary to estimate population size. Where distance sampling was not possible (<50 different observations), simple extrapolation of the overall sample density was used to estimate the total numbers of birds in the ship-based seabird survey areas. Further details are provided below.

Multi Covariate Distance Sampling using Distance computer programme

Multi Covariate Distance Sampling (MCDS) is a widely used and accepted statistical method that accounts for a major source of potential underestimation during surveys. The method has been demonstrated to produce accurate population estimates for seabirds (Buckland *et al.* 2001), and is widely available and accessible through the use of Distance 5.0 software (Thomas *et al.* 2002).

There are four basic assumptions of distance sampling that should be adhered to if an unbiased density estimate is to be obtained:

1. Birds directly on or close to the transect line are always detected.
2. Birds are detected at their initial location prior to natural movement or movement in response to the observer's presence. It is assumed that birds do not move in response to the survey platform.
3. Distances are accurately measured.
4. Objects are distributed randomly with respect to the survey transects.

All birds recorded on the sea surface '*in transe*ct' (on the main transects) were included for analysis. The data input to the *Distance* computer programme was restricted to those collected on the main transects, as the inclusion of data from 'short legs' risked double sampling of birds from the areas at the corners where the boat turned to begin the next main transect (Buckland *et al.* 2001).

Data collected during the 'snapshot' (i.e. flying birds in 'transect') were not suitable for distance sampling (Camphuysen *et al*. 2003). Since only data collected on the sea surface may be included in the distance sampling analyses, the population estimates may be artificially reduced, as they exclude birds in flight. In order to rectify overall population estimates, estimation of birds in flight using extrapolation of birds recorded at the time of the snapshot (i.e. 'in transect'), were added to population estimates on the sea surface.

The population size in flight was estimated by multiplying the overall density in flight by the total study area.

To calculate estimates of density and abundance for each survey area, two projects were developed in *Distance* with, Strata:Month and Strata:Season respectively as the region layer to allow the generation of estimates by month or season for each of the three study strata. Seasons are defined as Spring (March, April and May), Summer (June, July and August), Autumn (September, October and November) and Winter (December, January and February). The sampling Fraction was set at 0.5 as observations were obtained from a 90 degree arc down one side of the vessel. For each species a range of distribution models were assessed against one another by eye and using corrected Akaike's Information Criteria (AICc). In all cases other than for razorbills and herring gulls, models used a Hazard Rate key function with no adjustments terms (SMRU 2011c).

Detection functions were created globally and cluster (flock size), hour and observer were entered separately. The MCDS models were run for all species and compared against the original Conventional Distance Sampling (CDS) model, with the best being selected on the basis of AICc. Where sample size was less than a 100, the model was not run due to insufficient power. The MCDS-hour was selected for six species with the MCDS-observer being selected for razorbill only. The MCDS-cluster was not selected for any species (SMRU 2011c).

Density Surface Modelling

Density Surface Modelling takes into account the effects of detectability on sightings rates and the effects of environmental heterogeneity on their distribution. The output of the model is a continuous density surface made up of grid cells, each with its own density estimate and associated coefficient of variation. Density Surface Modelling has been undertaken for guillemot and razorbill for estimates of population density and bootstrapped variance estimates (SMRU 2011c).

Extrapolation of overall estimate

Where distance sampling using the *Distance* computer programme was not possible (<100 observations), simple extrapolations of the overall density have been used to estimate the total number of birds in the ship-based seabird survey areas. The extrapolation of overall density is a relatively quick and simple method of estimating total abundance within the sampled area. However, this method makes assumptions about the data used; overall density assumes that birds are uniformly distributed across the study site (i.e. there is no clumping due to social aggregation or habitat selection), and use of mean density is only accurate if sample densities are normally distributed.

Correction factors were applied to birds on the water to account for variations in detection at different distances from the ship's trackline. These were applied by multiplying the number of birds recorded for a species by its correction factor to give a value with which to calculate the density of each seabird species on the water. Due to the small sample size, it was not possible to calculate correction factors for the study area, instead published corrections factors based upon large data sets were applied to the data (Table 2-2).

The population size on the water was estimated by multiplying the corrected overall density per sampled area by the total study area. As correction factors cannot be applied to flying birds recorded 'in transect', simple extrapolation was used to estimate population size in flight as discussed in previous section. Estimated populations in flight and on water were added together to produce a total population size for the 'control' and proposed EOWDC survey areas.

Table 2-2: Correction factors from Skov *et al*. (1995).

Species	Correction Factors
Red-throated diver	1.4
Great cormorant	1.2
Northern fulmar	1.2
Northern gannet	1.4
Mew (common) gull	2.2
Common scoter	1.7
Herring gull	1.2
Great black-backed gull	1.7
Black-legged kittiwake	1.8
Sandwich tern	1.5
Common tern	1.5
Common guillemot/razorbill	1.6
Common guillemot	1.6
Razorbill	1.6
Atlantic puffin	2.0

Table 2-3 presents the species and months eligible for *Distance* during the Year 1 and Year 2 survey programme.

Table 2-3: Summary table of month/species where *Distance* was applicable in the 'control' and proposed EOWDC survey areas from Year 1 and Year 2 data.

Species	Year 1	Year 2
Red-throated diver	×	✓
Northern fulmar	×	✓
Northern gannet	×	✓
Great cormorant	×	✓
European shag	×	✓
Common gull	×	✓
Herring gull	×	✓
Black-legged kittiwake	July '07 [-1]	✓
Common guillemot	Feb 07 [-2], May 07 to Oct 07	✓
Razorbill	August 2007	✓
Atlantic puffin	Sept 07 [- 1]	✓

[-1] 'control' area only,[-2] EOWDC area only,

2.2 Vantage Point Surveys

Vantage Point (VP) Surveys were undertaken from a total of six locations between March 2005 and March 2008: Data obtained during 2005 VP surveys has been questioned by SNH and based on their advice subsequently removed from this assessment (SNH 2011). The remaining original data was obtained during the original phase of the project when the proposed location was closer to shore. Four locations were used throughout the vantage point surveys: Donmouth, Blackdog, Drums and Balmedie (Table 2-4) (EnviroCentre 2007; Alba Ecology 2008a,b).

Table 2-4: Vantage Point survey locations in Aberdeen Bay.

Years	Site	Elevation (metres)
April 2006 – March 2008	Donmouth	11
April 2006 – March 2008	Blackdog	16
April 2006 – March 2008	Balmedie	21
April 2006 – March 2008	Drums	16

Watches were conducted during daylight hours in conditions of good visibility, by a single observer with binoculars and telescope for two hours from each VP site. Two surveys were undertaken at each location most months, with up to four surveys per month in the then proposed EOWDC area (Donmouth and Blackdog) (Figure 2-5). Surveys were conducted at dawn and dusk (alternating between dawn and dusk surveys between each site visit). Dawn surveys started approximately 30 minutes before sunrise and dusk surveys extended to sunset or within about 15 minutes after.

At the start of each survey (along with any changes during the survey), the observer recorded the weather conditions, visibility, cloud cover, sea state, time of high tide and height (from tide tables), wind speed and direction, times of sunrise and sunset. In conditions of poor visibility (<1 km) surveys were not conducted or aborted if necessary.

The one to two hour long surveys were broken into 10 minute intervals, during which the observer counted all the individual birds moving through their telescope field of view (straight out from the VP, covering 0 - 3 km and approximately 60^{o}), noting their direction of flight, estimated distance from shore and flight height. If the birds exhibited notable behaviour, such as feeding, roosting, diving and fighting, this was also recorded.

Distance from shore was categorised into 0 - 1 km, 1 - 2 km, 2 - 3 km and 3+ km distance bands, where possible based on marker buoys (Balmedie: 1 km (NJ990175) and Blackdog: 2.3 km (NJ986132)). Flight heights were categorised in to 0-30 m, 30-150 m and 150+ m height bands, based on the size of the proposed wind turbines.

At the start of each survey period, the visible area was scanned with binoculars and the species, approximate number and behaviour of any birds on the sea surface and shore was recorded. During the two hour long survey general notes on birds on the sea surface and on the shore within the immediate field of view were recorded. Any significant changes to large feeding flocks out at sea or large movements of birds along the foreshore were also recorded.

A total of 235 VP surveys and 468.5 hours of surveys have been undertaken over a period of two years from four sites across different areas of Aberdeen Bay (Table 2-5).

Table 2-5: Vantage Point survey summary.

Location	No. of VP Surveys	No. of Hours
Drums	43	83
Balmedie	41	82.5
Blackdog	75	153.5
Donmouth	76	149.5
Total	235	468.5

Data obtained from vantage point surveys has been used to compliment the data collected further offshore from boat-based surveys. The benefits of vantage point surveys are that data on seabird distributions passing close to shore are obtained which may otherwise be missed from purely boat-based surveys. By comparing the data with those obtained from boat-based surveys, a better understanding of bird distributions are obtained. However, it is recognised that there is an increasing probability of birds being missed with increasing distance from the observer and unlike with boat-based data it is not possible to produce detectability functions to data collected by vantage points. In order to calculate detectability functions it is assumed that there is an even density of birds across the area or that there is a constant age or sex ratio. This is not the case from shore-based counts and therefore detectability functions cannot be produced from data collected from vantage point surveys.

2.3 Bird Detection Radar Surveys

Bird Detection radar has been used on three occasions during periods predicted to be of high migration in Aberdeen Bay: October 2005, April 2006 and April 2010 (Table 2-6).

The use of Bird Detection radar has allowed the tracking of bird movements continuously up to a range of 11 km including during periods of darkness or poor weather conditions. The radar could detect bird movements, their flight trajectory, flight speed and altitude to a height of 1.4 km. In favourable conditions the radar could track birds for up to 22 km and could detect animals as small as insects. The radar was used in all weather conditions including periods of poor visibility, rain and during hours of darkness.

The original surveys were undertaken at Easter Hatton and Drums but were later moved to Blackdog, closer to the proposed development area (Figure 2-5). The site was selected based on the location of the proposed development, available radar beam coverage, health and safety and logistics. The survey undertaken in April 2010 was aimed to coincide with period of peak pink-footed goose migration. However, delays in starting meant that it was not deployed until 24 April, which may have missed the majority of pink-footed goose spring migration.

In addition to manning and monitoring the live radar screens, detailed Vantage Point field monitoring synchronised with the radar deployment was undertaken during the surveys. The observers confirmed the species and composition of the tracks initially detected by radar as well as providing additional information such as flock size and formation, height and flight behaviour. The radar ornithologists swapped between the roles of radar monitoring and visual tracking approximately every 2 hours in order to minimise observer fatigue during periods of observation (Walls *et al.* 2010).

Table 2-6: Location and duration of radar studies undertaken in Aberdeen Bay.

Location	Range (km)	Start Date	End date	Running time (hr)	Reference
Drums	7	24 October 2005	29 October 2005	115	Walls *et al.* 2006
Easter Hatton	7	29 October 2005	3 November 2005	104	Walls *et al.* 2006
Blackdog	7	11 April 2007	26 April 2007	N/A	Simms *et al.* 2007
Blackdog	11	14 April 2010	29 April 2010	124	Walls *et al.* 2010

Note the total running time for radar studies undertaken between 11 April and 26 April 2007 are not presented in Simms et al. 2007 report but radar was routinely run 24 hrs per day and therefore the total running time was likely to have been in excess of 300 hrs.

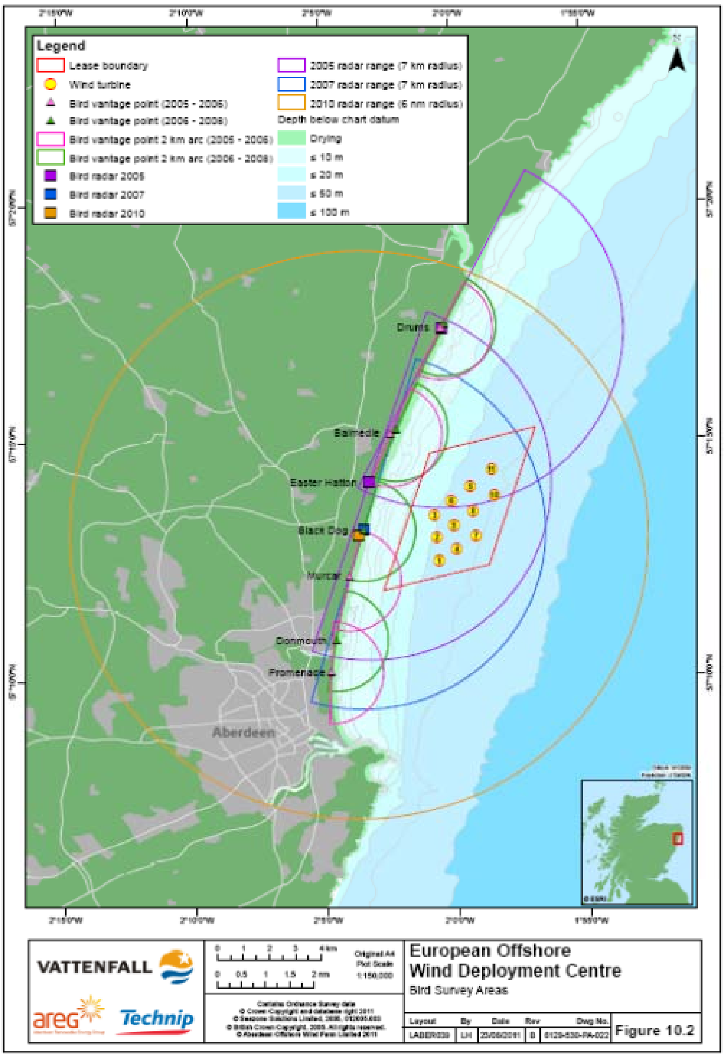


Figure 2-5: Location of radar and vantage point studies undertaken between 2006 to 2010 in relation to proposed development area.

3.0 IMPACT ASSESSMENT

3.1 Introduction

This section identifies the potential impacts arising from the proposed development on birds. It is based on site specific data from Aberdeen Bay obtained in order to inform the project and for the purposes of this assessment. It also draws upon other published information on the birds likely to be present in the area, i.e. North-east Scotland Bird Reports and JNCC reports. An assessment is undertaken for each species in Section 4.0.

Whenever possible, additional information from existing offshore wind farms has been used in order to inform the impact assessment.

A request for a formal scoping opinion was made in 2010 and a number of comments were received with respect to potential ornithological impacts arising from the proposed project. These have been considered when undertaking this impact assessment.

The assessment is based on the project parameters as outlined in the project description (Section 3 of the ES).

The approach identifies the main potential impacts on birds during each of the development phases based on published literature.

Potential sensitivities have been identified based on the value of the receptor, i.e. nature conservation value. These sensitivities are considered against the potential magnitude and duration of effects and the significance identified.

3.2 Potential Impacts

There are a number of publications that provide detailed analysis of the potential impacts the development of an offshore wind farm may have on birds (e.g. Percival 2001; Langston and Pullan 2003; Drewitt and Langston 2006; Zucco *et al*. 2006).

The conclusions from all the publications identify three (or four if disturbance is considered separate from displacement) main potential impacts:

Collision risk

Birds are at risk of colliding with wind turbines. The level of collision depends on the location and size of the development and the species present. Different species are at varying risks of collision depending on a number of factors including the heights at which they fly and the proportion of time that they are flying within the range of the rotor blades. Species such Auks, Divers and Scoter fly predominantly below rotor height, where as other species such as Gulls may more frequently fly at rotor height. Avoidance rates are very important in determining the level of risk. Far field avoidance occurs when birds make detours to avoid flying through the wind farms at distances of one or more kilometres; this has been reported for many species, e.g. gannets, Geese and Swans and sea-duck (Cook *et al*. 2012). Near-field avoidance occurs when a bird makes a quick detour at relatively close proximity to the wind turbines. Other factors influencing collision risk include the frequency of passage, i.e. breeding birds flying through a site to and from a breeding colony and potentially weather conditions and visibility with a potentially greater risk to birds during periods of poorer weather or at night. Overall, the majority of studies pertaining to offshore wind farms have indicated very low collision risks with most species having near-field avoidance rates of 99% or more and some far-field avoidance rates ranging from 50% for Divers and common eider to over 90% for gannets and common scoter (Cook *et al*. 2012). The potential significance of any collision mortality depends on the population size, its conservation status, the longevity of the species and its fecundity rate.

Long-lived species with low fecundity rates and with small or declining populations are at greater risk of being significantly affected by collision mortality.

Displacement

Birds that would otherwise use an area may avoid entering the wind farm and therefore be displaced. The displacement may be caused by a number of reasons. Birds may not enter the site due to the physical presence of the wind turbines, as may be the case for red-throated diver, or they may be disturbed (a disturbance impact) from the site by the vessels associated with the development, e.g. Divers and Scoter. There may also be an indirect impact on the food supply that could be reduced and therefore birds search elsewhere for their prey, e.g. Terns.

The level of displacement reported has varied across species and sites with some displacement identified for Divers, Cormorants and possibly Auks. The significance of any displacement, should it occur, is dependent on the scale and duration of impact and whether other suitable sites are available to which the birds may go (Drewitt and Langston 2006).

Barrier effects

Birds may avoid flying through the wind farms and select to fly over or around them. Should they choose to fly around them then this may entail flying further than they would otherwise have done so. Many species have been recorded avoiding offshore wind farms by flying around them, often by altering course at a distance of 1 km or more, e.g. wildfowl and gannets (Zucco *et al.* 2006). This increase in flight distance causes a corresponding increase in energy expenditure that may, depending on the frequency that the effect occurs and the fitness of the individual bird, have a negative impact on the bird. The greatest concerns arise when birds undertake frequent flights around the wind farm, e.g. to and from feeding grounds or roost sites (Drewitt and Langston 2006).

The impact assessment has been based on the above recognised potential effects.

3.3 Temporal Scales

There are four main phases in the development proposed programme that are considered in the impact assessment:

- Pre-construction,
- Construction,
- Operation,
- Decommissioning.

Pre-construction phase

During the pre-construction phase, baseline data was obtained using boat-based, land-based and radar surveys. The collection of the data over a number of years provides baseline information on usage of the proposed development area and further afield by birds that have the potential to be impacted. It provides the basis upon which the potential impacts can be assessed and against which any changes in populations can be measured.

Construction phase

The construction phase is of short to medium duration (i.e. possibly over more than one year) and consequently potential impacts arising from it are predicted to also be up to a medium duration. As this is a demonstrator project the exact type of turbines that may be installed is still to be determined. It is not predicted that once demonstrator turbines have been installed that they will be replaced prior to the end of their expected operating life. Therefore no on-going construction works are predicted.

Construction activities involve the use of a number of vessels to install the planned 11 turbines and cables that may cause disturbance and consequently displacement to species that avoid vessels, e.g. Divers and Scoter. The installation of turbines may cause the temporary displacement of prey species depending on the installation technique, e.g. pile-driving.

Operational phase

Potential impacts arising from the operational phase are collision mortality, displacement and barrier effects. There may be some disturbance from maintenance vessels that could cause displacement and a very small loss of habitat due to the direct physical impact on the seabed of the eleven wind turbines.

Decommissioning

How the turbines will eventually be decommissioned is still to be determined but it will involve the use of a number of vessels and the use of cutting equipment. The potential effects arising from decommissioning are predicted to be similar to those from installation, i.e. displacement.

Development phase	Potential impacts
Construction	Displacement from vessel activity and installation, e.g. piling. Secondary impacts on prey species from piling.
Operation	Collision with rotating blades.
	Displacement due to avoidance behaviour resulting in loss of foraging or roosting habitats and disturbance from maintenance vessel activity.
	Increased energetic expenditure as birds fly around development area.
	Direct habitat loss.
Decommissioning	Displacement from vessel activity.

3.4 Designated Sites

Although the proposed site does not lie within a designated area, there are a number of SPAs along the east coast of Scotland that have the potential to be impacted by the proposed development. For the purposes of the EIA, qualifying species from SPAs between Troup, Pennan and Lion's Head 74 km to the north and Forth Islands SPA approximately 134 km to the south have been considered (Table 3-1) and assessed against the relevant Conservation Objectives. The selection of sites is based largely on the potential foraging range (Thaxter *et al*. 2012) or known passage routes of the species recorded during surveys undertaken within the proposed development area and on the SNH response to the scoping documents (SNH 2010b). Additional sites have been included based on SNH response to the EOWDC application (SNH 2011a).

For the purposes of the impact assessment all SPA species have been considered to be Very Highly sensitive if individually cited or if cited as part of an assemblage. The potential effects on SPA species are assessed within the main impact section (Section 4.0).

Conservation Objectives

To avoid deterioration of the habitats of the qualifying species (listed [*for each site*]) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and

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

- Population of the species as a viable component of the site,
- Distribution of the species within site,
- Distribution and extent of habitats supporting the species,
- Structure, function and supporting processes of habitats supporting the species,
- No significant disturbance of the species.

Table 3-1: SPAs identified as being at potential risk of adverse effect from proposed project (amended following SNH advice (SNH 2011a)).

SPA	Approx. distance EOWDC (km)	Qualifying species
Ythan Estuary, Sands of Forvie and Meikle Loch SPA	7.2	Article 4.1: *Breeding;* Sandwich tern, common tern, little tern. Article 4.2: *Winter;* pink-footed geese, common eider, *Breeding;* diverse assemblage of breeding seabirds (13 species). Regularly supporting over 20,000 waterfowl including redshank and lapwing.
Buchan Ness to Collieston Coast SPA	9.5	Article 4.2: Regularly supporting at least 20,000 seabirds. *Breeding;* the area regularly supports 95,000 individual seabirds including: guillemot, kittiwake, herring gull, shag, and fulmar.
Loch of Skene SPA	21	Article 4.2: *Winter;* greylag goose.
Fowlsheugh SPA	31.1	Article 4.2: Regularly supporting in excess of 20,000 individual seabirds. The colony regularly supports 145,000 seabirds. *Breeding*: Regularly supporting populations of European importance of the migratory species: common guillemot, black-legged kittiwake, razorbill, fulmar, herring gull.
Loch of Strathbeg SPA	47.6	Article 4.1: *Breeding;* Sandwich tern. *Winter;* barnacle goose, whooper swan. Article 4.2: *Winter*; greylag goose, pink-footed Goose Regularly supporting at least 20,000 waterfowl. Over winter supports 49,452 individual waterfowl including: teal, greylag goose, pink-footed goose, barnacle goose, whooper swan.
Montrose SPA	61	Article 4.2: *Winter;* greylag goose, knot, pink-footed goose, redshank. Regularly supporting at least 20,000 waterfowl. *Winter*; the area regularly supports 54,917 individual waterfowl, including: dunlin, oystercatcher, common eider, wigeon, shelduck, redshank, knot, greylag goose, pink-footed goose.
Troup, Pennan and Lion's Head SPA	74.3	Article 4.1: *Breeding*; guillemot. Article 4.2: Regularly supporting at least 20,000 seabirds *Breeding*, 150,000 individual seabirds including: razorbill, kittiwake, herring gull, fulmar, guillemot.
Firth of Tay and Eden Estuary SPA	96	Article 4.1: *Breeding*; little tern, marsh harrier. *Winter*; bar-tailed godwit. Article 4.2: *Winter*; greylag goose, pink-footed Goose, redshank. Regularly supporting at least 20,000 waterfowl. In winter, the area regularly supports 34,074 individual waterfowl including: velvet scoter, pink-footed goose, greylag goose, redshank, cormorant, shelduck, common eider, bar-tailed godwit, common scoter, black-tailed godwit, goldeneye, red-breasted Merganser, goosander, oystercatcher, grey plover, sanderling, dunlin, long-tailed duck.

Firth of Forth SPA	124	Article 4.1: *Passage*; Sandwich tern, *Winter*; bar-tailed godwit, golden plover, red-throated diver, Slavonian grebe. Article 4.2: *Winter;* knot, pink-footed goose, redshank, shelduck, turnstone. Article 4.2: Regularly supporting at least 20,000 waterfowl. *Winter*, regularly supports 86,067 individual waterfowl including: scaup, Slavonian grebe, golden plover, bar-tailed godwit, pink-footed goose, shelduck, knot, redshank, turnstone, great crested grebe, cormorant, red-throated diver, mallard, curlew, common eider, long-tailed duck, common scoter, velvet scoter, goldeneye, red-breasted merganser, oystercatcher, ringed plover, grey plover, lapwing, dunlin, wigeon.
Imperial Dock, Leith SPA	130	Article 4.1: *Breeding;* common tern.
Forth Islands SPA	134	Article 4.1: *Breeding;* Arctic tern, common tern, roseate tern, Sandwich tern. Article 4.2: *Breeding*; gannet, lesser black-backed gull, puffin, shag. Regularly supporting at least 20,000 seabirds Breeding season the area regularly supports 90,000 individual seabirds including razorbill, guillemot, kittiwake, herring gull, cormorant, fulmar, puffin, lesser black-backed gull, shag, gannet, Arctic tern, common tern, roseate tern, Sandwich tern.
Forth Islands SPA	134	Article 4.1: *Breeding*; Arctic tern, common tern, roseate tern, Sandwich tern. Article 4.2: *Breeding*; gannet, lesser black-backed gull, puffin, shag. Regularly supporting at least 20,000 seabirds. Breeding season the area regularly supports 90,000 individual seabirds including razorbill, guillemot, kittiwake, herring gull, cormorant, fulmar, puffin, lesser black-backed gull, shag, gannet, Arctic tern, common tern, roseate tern, Sandwich tern.
East Caithness Cliffs SPA	*c.*180	Article 4.1: *Breeding*: Peregrine. Article 4.2 *Breeding;* guillemot, herring gull, kittiwake, razorbill, shag. Regularly supporting at least 20,000 seabirds. *Breeding*, the area regularly supports 300,000 individual seabirds including puffin, great black-backed gull, cormorant, fulmar, razorbill, guillemot, kittiwake, herring gull, shag.
Copinsay SPA	*c.* 203	Article 4.2: Regularly supporting at least 20,000 seabirds. Regularly supports 70,000 individual seabirds including guillemot, kittiwake, great black-backed gull, fulmar.
North Caithness Cliffs SPA	*c.* 212	Article 4.1: *Breeding* peregrine, guillemot. Article 4.2 Regularly supporting at least 20,000 seabirds. During the breeding season, the area regularly supports 110,000 individual seabirds including puffin, razorbill, kittiwake, fulmar, guillemot.
Caithness and Sutherland Peatlands SPA	*c.* 213	Article 4.1: *Breeding:* black-throated Diver, golden eagle,

		golden plover, hen harrier, merlin, red-throated diver, short-eared owl, wood sandpiper. Article 4.2: *Breeding:* common scoter, dunlin, greenshank, wigeon.
Hoy SPA	*c.* 217	Article 4.1: *Breeding;* peregrine, red-throated diver. Article 4.2: *Breeding* - great skua. Regularly supporting at least 20,000 seabirds. Regularly supports 120,000 individual seabirds including, puffin, guillemot, kittiwake, great black-backed gull, Arctic skua, fulmar, great skua.
Fair Isle SPA	*c.* 262	Article 4.1: *Breeding;* Arctic Tern, Fair Isle wren. Article 4.2: *Breeding*; guillemot. Regularly supports 180,000 individual seabirds including puffin, razorbill, kittiwake, great skua, Arctic skua, shag, gannet, fulmar, guillemot and Arctic tern.
Sumburgh Head SPA	*c.* 300	Article 4.1: *Breeding*; Arctic tern. Article 4.2: Regularly supporting at least 20,000 seabirds. The area regularly supports 35,000 individual seabirds guillemot, kittiwake, fulmar and Arctic tern.
Foula SPA	*c.* 329	Article 4.1: *Breeding;* Arctic tern, Leach's petrel, red-throated diver. Article 4.2: *Breeding;* great skua, guillemot, puffin, shag, Regularly supporting at least 20,000 seabirds. Regularly supports 250,000 individual seabirds Leach's petrel, razorbill, kittiwake, Arctic skua, fulmar, puffin, great skua, shag, Arctic tern.
Noss SPA	*c.* 334	Article 4.2: *Breeding;* gannet, great Skua, guillemot Regularly supports 100,000 individual seabirds including: puffin, kittiwake, fulmar, guillemot, great skua, gannet.
Fetlar SPA	*c.* 365	Article 4.1: *Breeding;* Arctic tern, red-necked phalarope. Article 4.2: *Breeding;* dunlin, great skua, whimbrel. Article 4.2: Regularly supporting at least 20,000 seabirds. During the breeding season, the area regularly supports 22,000 individual seabirds including: Arctic Skua, fulmar, great skua, Arctic tern and red-necked phalarope.
Ronas Hill – North Rona and Tingon SPA	*c.* 380	Article 4.1: *Breeding;* merlin, red-throated diver.
Otterswick and Graveland SPA	*c.* 383	Article 4.1: *Breeding:* red-throated diver.
Hermaness Saxa Vord and Valla Field SPA	*c.* 413	Article 4.1: *Breeding;* red-throated diver. Article 4.2: *Breeding;* gannet, great skua, puffin Regularly supports 152,000 individual seabirds including guillemot, kittiwake, shag, fulmar, puffin, great skua, gannet.

Numbers of Seabirds Recorded

A total of 40 species of seabird and waterfowl was recorded from two years of boat-based surveys collected between February 2007 to April 2008 and August 2010 to August 2011.

The most abundant species recorded across the two years of boat-based surveys were:

- eider,
- common scoter,
- gannet,
- kittiwake,
- common gull,
- herring gull,
- guillemot,
- razorbill,
- puffin.

For all of which over a thousand individuals were recorded (Table 3-2).

Table 3-2: Total numbers of species recorded from Aberdeen Bay boat-based surveys in Year 1 and Year 2.

Species	Year 1			Year 2				TOTAL
	EOWDC	Control	**Total**	North	East	South	**Total**	
Greylag goose	2	0	**2**	0	0	0	**0**	**2**
Barnacle goose	817	14	**831**	0	0	0	**0**	**831**
Goose *Sp*.	85	180	**265**	0	0	0	**0**	**265**
Shelduck	4	3	**7**	0	0	0	**0**	**7**
Wigeon	1	28	**29**	0	0	0	**0**	**29**
Teal	1	2	**3**	0	0	2	**2**	**5**
Tufted duck	0	2	**2**	0	0	0	**0**	**2**
Gadwall	0	0	**0**	2	0	1	**3**	**3**
Mallard	0	2	**2**	2	0	1	**3**	**5**
Eider	1,473	220	**1,693**	968	0	4	**972**	**2,665**
Long-tailed duck	17	9	**26**	58	1	1	**60**	**86**
Common scoter	5,626	1,421	**7,047**	282	0	27	**309**	**7,356**
Velvet scoter	9	5	**14**	0	0	0	**0**	**14**
Surf Scoter	0	0	**0**	1	0	0	**1**	**1**
Goldeneye	3	2	**5**	2	0	0	**2**	**7**
Duck *Sp*.	0	8	**8**	0	0	0	**0**	**8**
Red-breasted merganser	0	1	**1**	1	0	0	**1**	**2**
Red-throated diver	322	202	**524**	300	5	27	**332**	**854**
Black-throated diver	1	1	**2**	2	0	0	**2**	**4**
Great northern diver	0	0	**0**	1	0	0	**1**	**1**
Red-throated/black throated diver	4	16	**20**	5	0	0	**5**	**25**
Fulmar	349	293	**642**	212	380	250	**842**	**1,466**
Manx shearwater	10	12	**22**	52	26	18	**96**	**118**
Gannet	412	417	**829**	781	545	478	**1,804**	**2,633**
Cormorant	49	189	**238**	127	0	12	**139**	**377**
Shag	20	20	**40**	87	1	143	**231**	**271**
Cormorant/Shag	5	6	**11**	0	0	0	**0**	**11**
Golden plover	2	0	**2**	0	0	0	**0**	**2**
Knot	0	0	**0**	2	0	0	**2**	**2**
Dunlin	2	1	**3**	2	0	1	**3**	**6**
Calidris *sp.*	1	0	**1**	0	0	0	**0**	**1**
Curlew	3	0	**3**	0	0	1	**1**	**4**
Turnstone	0	0	**0**	1	0	3	**4**	**4**
Oystercatcher	0	0	**0**	2	0	0	**2**	**2**

Species	Year 1			Year 2				TOTAL
	EOWDC	Control	**Total**	North	East	South	**Total**	
Arctic skua	25	39	**64**	32	1	2	**35**	**99**
Great skua	13	14	**27**	17	10	6	**33**	**60**
Pomarine skua	0	0	**0**	0	1	0	**1**	**1**
Skua *sp.*	0	2	**2**	0	0	0	**0**	**2**
Little gull	0	0	**0**	3	0	0	**3**	**3**
Kittiwake	981	2,197	**3,178**	3,352	1,790	2,109	**7,251**	**10,429**
Black-headed gull	8	1	**9**	6	0	3	**9**	**18**
Common gull	653	589	**1,242**	162	41	190	**393**	**1,635**
Herring gull	619	454	**1,073**	1,244	171	1,107	**2,522**	**3,595**
Lesser black-backed gull	6	0	**6**	50	9	7	**66**	**72**
Great black-backed gull	132	142	**274**	134	23	25	**182**	**456**
Great black-backed/herring gull	6	41	**47**	1	1	0	**2**	**49**
Large gull *sp.*	0	5	**5**	2	0	1	**3**	**8**
Sandwich tern	44	161	**205**	25	0	26	**51**	**256**
Common tern	43	158	**201**	75	4	6	**85**	**286**
Arctic tern	0	6	**6**	283	72	11	**366**	**372**
'Commic' tern	20	34	**54**	111	6	36	**153**	**207**
Guillemot	2,534	3,881	**6,415**	10,231	2,632	4,164	**17,027**	**23,442**
Razorbill	714	828	**1,542**	1,317	432	1,355	**3,104**	**4,646**
Guillemot/Razorbill	742	1,527	**2,269**	1,304	342	1,223	**2,869**	**5,138**
Puffin	176	378	**554**	285	525	93	**903**	**1,458**
Little auk	11	5	**16**	1	40	15	**56**	**72**
Little auk/puffin	1	1	**2**	0	0	0	**0**	**2**
Carrion Crow	4	0	**4**	0	0	0	**0**	**4**
Jackdaw	0	1	**1**	0	0	0	**0**	**1**
Skylark	1	0	**1**	0	0	0	**0**	**1**
Meadow pipit	8	3	**11**	1	0	0	**1**	**12**
Peregrine	0	1	**1**	0	0	0	**0**	**1**
Starling	0	0	**0**	0	0	1	**1**	**1**
Swift	0	1	**1**	0	0	3	**3**	**4**
Swallow	2	0	**2**	0	0	3	**3**	**5**

Note – 'EOWDC' covers a significantly greater area than just the proposed development area and does not represent the number of birds specifically within the proposed EWODC development lease boundary but does for the wider area.

Table 3-3: Monthly counts of birds from boat-based surveys undertaken in Aberdeen Bay in Year 1 and Year 2.

Species	Year	Month												Total
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Eider	Year 1	7	61	22	84	5	1	0	450	572	342	149	0	**1,693**
	Year 2	0	3	24	5	nc	0	0	490	434	nc	16	0	**972**
Common scoter	Year 1	454	168	6	528	613	8	2,601	1,018	569	387	630	65	**7,047**
	Year 2	99	0	11	27	nc	49	1	10	102	nc	10		**309**
Surf scoter	Year 1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Year 2	0	0	0	0	nc	0	0	1	0	nc	0	0	**1**
Velvet scoter	Year 1	0	2	0	0	0	0	5	0	0	7	0	0	**14**
	Year 2	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Goldeneye	Year 1	0	0	0	3	0	0	0	0	0	0	2	0	**5**
	Year 2	0	0	0	0	nc	0	2	0	0	nc	0	0	**2**
Teal	Year 1	0	0	0	0	0	0	0	0	0	1	2	0	**3**
	Year 2	0	0	0	0	nc	0	0	2		nc	0	0	**2**
Long-tailed duck	Year 1	0	4	0	9	0	0	0	0	0	7	6	0	**26**
	Year 2	19	30	10	1	nc	0	0	0		nc	0	0	**60**
Barnacle goose	Year 1	0	0	0	0	0	0	0	0	0	831	0	0	**831**
	Year 2	0	0	0	0	nc	0	0	0	0	nc	0	0	**0**
Greylag goose	Year 1	0	0	0	2	0	0	0	0	0	0	0	0	**2**
	Year 2	0	0	0	0	nc	0	0	0	0	nc	0	0	**0**
Goose *Sp.*	Year 1	85	0	0	0	0	0	0	0	0	0	180	0	**265**
	Year 2	0	0	0	0	nc	0	0	0	0	nc	0	0	**0**
Shelduck	Year 1	1	0	0	2	4	0	0	0	0	0	0	0	**7**
	Year 2	0	0	0	0	nc	0	0	0		nc	0	0	**0**
Red-throated diver	Year 1	41	91	40	95	87	34	15	9	28	17	35	32	**524**
	Year 2	106	39	39	1	nc	28	10	17	13	nc	79	0	**332**
Black-throated diver	Year 1	0	0	0	2	0	0	0	0	0	0	0	0	**2**
	Year 2	0	2	0	0	nc	0	0	0	0	nc	0	0	**2**
Red-thr'td/black-thr'td diver	Year 1	1	5	1	10	0	1	0	1	0	0	1	0	**20**
	Year 2	0	0	4		nc	1	0	0	0	nc	0	0	**5**
Great northern diver	Year 1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Year 2	1	0	0	0	nc	0	0	0	0	nc	0	0	**1**
Red-breasted merganser	Year 1	0	0	1	0	0	0	0	0	0	0	0	0	**1**

Species	Year	Month												Total
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
	Year 2	0	0	0		nc	1	0	0	0	nc	0	0	**1**
Cormorant	Year 1	5	20	2	63	10	20	9	6	29	30	35	9	**238**
	Year 2	18	1	6	4	nc	21	28	21	32	nc	8	0	**139**
Shag	Year 1	1	0	1	10	1	2	3	0	5	9	6	2	**40**
	Year 2	8	17	14	19	nc	15	76	65	15	nc	2	0	**231**
Cormorant/Shag	Year 1	0	5	0	3	0	0	0	0	0	0	4	1	**13**
	Year 2	0	0	0	0	nc	0	0	0	0	nc	0	0	**0**
Fulmar	Year 1	34	78	18	333	50	52	18	13	17	0	0	29	**642**
	Year 2	45	22	78	40	nc	130	165	169	178	nc	15	0	**842**
Manx shearwater	Year 1	0	0	0	0	1	6	5	1	7	0	2	0	**22**
	Year 2	0	0	0	2	nc	43	26	18	7	nc	0	0	**96**
Sooty shearwater	Year 1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Year 2	0	0	0	0	nc	0	0	1		nc	2	0	**2**
Storm petrel	Year 1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Year 2	0	0	0	0	nc	1	0	0	0	nc	0	0	**1**
Gannet	Year 1	3	25	0	87	82	128	84	129	77	192	4	18	**829**
	Year 2	2	3	43	96	nc	429	446	406	348	nc	31	0	**1,804**
Little gull	Year 1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Year 2	0	0	0	0	nc	0	0	3		nc	0	0	**3**
Kittiwake	Year 1	1	7	4	766	302	243	1,446	316	54	22	17	0	**3,178**
	Year 2	18	10	148	503	nc	2,532	3,363	422	137	nc	118	0	**7,251**
Common gull	Year 1	97	311	156	205	3	10	1	21	26	175	143	92	**1,240**
	Year 2	169	55	65	7	nc	37	10	1	5	nc	44	0	**393**
Herring gull	Year 1	19	58	20	135	0	154	575	5	4	19	66	18	**1,073**
	Year 2	97	73	238	404	nc	993	455	22	8	nc	232	0	**2,522**
Lesser black-backed gull	Year 1	0	0	0	1	0	5	0	0	0	0	0	0	**6**
	Year 2	0	2	4	3	nc	11	2	4	40	nc	0	0	**66**
Black-headed gull	Year 1	0	0	1	0	0	0	0	0	0	0	8	0	**9**
	Year 2	0	1	0	0	nc	5	1	0	0	nc	2	0	**9**
Great black-backed gull	Year 1	30	32	18	39	0	34	45	0	27	13	16	20	**274**
	Year 2	19	5	22	12	nc	11	5	72	17	nc	19	0	**182**
Great black-backed/herring gull	Year 1	0	2	0	4	0	0	0	0	40	0	1	0	**47**

Species	Year	Month												Total
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
	Year 2	0	0	0	0	nc	0	1	1		nc	0	0	**2**
Large gull *sp.*	Year 1	0	5	0	0	0	0	0	0	0	0	0	0	**5**
	Year 2	0	0	0	0	nc	1	1	1		nc	0	0	**3**
Great skua	Year 1	0	0	0	0	0	0	3	20	4	0	0	0	**27**
	Year 2	0	0	0	0	nc	1	13	12	7	nc	0	0	**33**
Arctic skua	Year 1	0	0	0	0	0	7	19	10	23	4	1	0	**64**
	Year 2	0	0	0	0	nc	2	11	6	8	nc	8	0	**35**
Pomarine skua	Year 1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Year 2	0	0	0	0	nc	0	0	0	0	nc	1	0	**1**
Skua *sp.*	Year 1	0	0	0	0	0	1	0	0	1	nc	0	0	**2**
	Year 2	0	0	0	0	nc	0	0	0	0	nc	0	0	**0**
Arctic tern	Year 1	0	0	0	3	0	0	3	0	0	0	0	0	**6**
	Year 2	0	0	0	0	nc	60	199	104	3	nc	0	0	**366**
Common tern	Year 1	0	0	0	1	30	29	125	6	10	0	0	0	**201**
	Year 2	0	0	0	0	nc	9	44	24	8	nc	0	0	**85**
Sandwich tern	Year 1	0	0	0	41	61	28	57	0	18	0	0	0	**205**
	Year 2	0	0	0	12	nc	13	22	0	4	nc	0	0	**51**
'Commic' tern	Year 1	0	0	0	5	1	0	14	9	25	0	0	0	**54**
	Year 2	0	0	0	0	nc	9	114	23	7	nc	0	0	**153**
Puffin	Year 1	0	1	0	23	10	44	73	133	155	102	12	1	**554**
	Year 2	1	4	4	25	nc	122	375	276	71	nc	25	0	**903**
Little auk	Year 1	0	0	0	5	0	0	0	0	0	0	9	2	**16**
	Year 2	0	0	0	0	nc	0	0	0	0	nc	56	0	**56**
Little auk/puffin	Year 1	0	0	0	0	0	0	0	0	0	0	2	0	**2**
	Year 2	0	0	0	0	nc	0	0	0	0	0	0	0	**0**
Guillemot	Year 1	68	229	75	500	494	866	2,148	851	686	374	76	48	**6415**
	Year 2	714	279	745	657	nc	6,753	4,480	2,092	663	nc	644	0	**17,027**
Razorbill	Year 1	18	57	27	405	67	100	139	276	220	153	53	27	**1,542**
	Year 2	15	59	255	365	nc	590	1,333	338	89	nc	60	0	**3,104**
Guillemot/Razorbill	Year 1	17	74	87	525	48	203	616	345	71	230	16	37	**2,269**
	Year 2	4	3	173	156	nc	49	2,480	1	0	nc	3	0	**2,869**
Duck *Sp.*	Year 1	0	8	0	0	0	0	0	0	0	0	0	0	**8**

Species	Year	Month												Total
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
	Year 2	0	0	0	0	nc	0	0	0	0	0	0	0	**0**
Mallard	Year 1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Year 2	0	0	0	0	nc	0	0	0	2	nc	1	0	**3**
Wigeon	Year 1	0	0	0	1	0	0	0	0	20	8	0	0	**29**
	Year 2	0	0	0	0	nc	0	0	0	0	nc	0	0	**0**
Tufted duck	Year 1	0	0	0	2	0	0	0	0	0	0	0	0	**2**
	Year 2	0	0	0	0	nc	0	0	0	0	nc	0	0	**0**
Gadwall	Year 1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Year 2	0	0	0	0	nc	0	3	0	0	nc	0	0	**3**
Whooper swan	Year 1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Year 2	0	0	10	0	nc	0	0	0	0	nc	0	0	**10**
Carrion crow	Year 1	0	0	0	4	0	0	0	0	0	0	0	0	**4**
	Year 2	0	0	0	0	nc	0	0	0	0	nc	0	0	**0**
Calidris *Sp.*	Year 1	0	0	0	1	0	0	0	0	0	0	0	0	**1**
	Year 2	0	0	0	0	nc	0	0	0	0	nc	0	0	**0**
Dunlin	Year 1	0	0	0	0	0	0	0	2	0	0	1	0	**3**
	Year 2	0	0	0	0	nc	0	0	3		nc	0	0	**3**
Curlew	Year 1	0	0	0	3	0	0	0	0	0	0	0	0	**3**
	Year 2	0	0	0	0	nc	0	1	0	0	nc	0	0	**1**
Knot	Year 1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Year 2	0	0		0	nc	0	0	2		nc	0	0	**2**
Golden plover	Year 1	0	0	0	0	0	0	0	0	2	0	0	0	**2**
	Year 2	0	0	0	0	nc	0	0	0	0	nc	0	0	**0**
Turnstone	Year 1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Year 2	0	0	0	0	nc	0	1	3		nc	0	0	**4**
Oystercatcher	Year 1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Year 2	0	0	0	1	nc	0	1	0	0	nc	0	0	**2**
Skylark	Year 1	0	1	0	0	0	0	0	0	0	0	0	0	**1**
	Year 2	0	0	0	0	nc	0	0	0	0	nc	0	0	**0**
Starling	Year 1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Year 2	0	0	0	0	0	0	0	0	0	0	1	nc	**1**
Pied wagtail	Year 1	0	0	1	0	0	0	0	0	0	0	0	0	**1**

Species	Year	Month												Total
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
	Year 2	0	0	0	0	nc	0	0	0	0	nc	0	0	**0**
Peregrine	Year 1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Year 2	0	0	0	0	nc	0	0	0	0	nc	0	0	**0**
Meadow pipit	Year 1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Year 2	0	0	0	1	nc	0	0	0	0	nc	0	0	**1**
Jackdaw	Year 1	0	0	0	3	0	0	0	0	0	0	0	0	**3**
	Year 2	0	0	0	0	nc	0	0	0	0	nc	0	0	**0**
Swift	Year 1	0	0	0	0	0	0	1	0	0	0	0	0	**1**
	Year 2	0	0	0	0	nc	3		0		nc	0	0	**3**
Swallow	Year 1	0	0	0	1	0	0	0	0	1	0	0	0	**2**
	Year 2	0	0	0	0	nc	0	0	5		nc	0	0	**5**
Grey heron	Year 1	0	0	0	0	0	0	0	3	0	0	0	0	**3**
	Year 2	0	0	0	0	nc	0	0	1		nc	0	0	**1**

3.5 EIA Methods and Potential Significance of Impacts

Species regularly recorded offshore during site specific surveys have been assessed in the main section of this document (Section 4.0). Records of species infrequently recorded are summarised in Section 5.0. It is recognised that species may also occur in the area that were not recorded during surveys and others may have been under recorded due to their nocturnal flights or intermittent migration. Although there is some migration across Aberdeen Bay as there is across the whole of North-east Scotland, based on data obtained from two years of vantage point and boat based surveys and three radar surveys, along with published information (e.g. North-east Scotland Bird Reports, Buckland *et al.* 2009), there are no migration corridors across Aberdeen Bay. Therefore, for those species only infrequently recorded or not recorded offshore, i.e. many waders, wildfowl and passerines, no further assessment has been made as there is not predicted to be any significant or adverse effect to those species from the proposed development.

It is recognised that the strict use of a matrix approach when undertaking an EIA can be inflexible and risks drawing erroneous conclusions. However, the use of an impact matrix can and does provide structure to an otherwise judgemental process and as long as the matrix is used appropriately it can be a useful tool in identifying the overall potential significance of an impact. The development of sensitivity tables have been published by COWRIE and provide focussed and robust tables specific to potential impacts (Maclean *et al.* 2009). More recent vulnerability assessment has also been commissioned by Marine Scotland and the results from this study have also been considered (Furness and Wade 2012).

For the purposes of this EIA an evidence based approach has been used to determine potential impacts as well as expert judgement based on the baseline information and results from studies undertaken at other offshore wind farms. An impact matrix has been used to provide a structure and consistency of approach and has been used as tool to help inform the impact assessment. The structure and content of the tables are based on those originally developed by Percival *et al.* (1999) and developed further by Maclean *et al.* (2009). They have been widely used in various similar forms for nearly all offshore wind farms. However, the results from the impact matrices have not been considered to be definitive, nor in isolation. The assessment is ultimately based on the latest published data available on potential impacts, i.e. wherever possible an evidence based approach has been adopted.

Determining Significance

What may be considered to be significant differs across legislative requirements.

Under the EIA Regulations, significance is used to determine the relative importance of an effect on a feature, whereas under the Habitats Regulations it is a coarse filter to determine whether a further Appropriate Assessment is required (IEEM 2010).

Species' sensitivities are based on the nature conservation value (NCV) of the species and the sensitivity of the species to a particular impact.

To assess the sensitivity of a species a series of definitions have been used to describe the potential nature conservation value of the species (Table 3-4) (Percival 1999).

> *Very High*: - For the purposes of the EIA a very high sensitivity was identified for all species that are listed as cited interests for an SPA and within range of potential interaction, i.e. was within the known foraging range of the species. Foraging ranges were taken from BirdLife International (BirdLife International 2012), Roos (2010) and Thaxter *et al.* (2012).

The SPAs that were identified as having a potential for interaction are presented in Table 3-1. These were amended following responses from SNH (SNH 2011a).

High: - A definition of high sensitivity was given for species identified as being part of an SPA assemblage or with potential for more than 1% of the population to be affected.

Medium: - Species were considered to be of medium sensitivity if a regionally important population was potentially affected. For the purposes of the EIA the regional population was defined as being between the Firth of Forth and Troup Head. Regional populations were based on latest SPA populations and mean 5 year peak WeBS counts (Table 3-19). If greater than 1% of the regional population was considered as being potentially affected then the species was considered to be Medium sensitivity.

Low: All species that were not covered by any of the above categories were given a low sensitivity.

Table 3-4: Definition of terms relating to the nature conservation value of a species.

Sensitivity	Definition
Very High	Cited interest of SPAs. Cited means mentioned in the citation test for the site as a qualifying species for which the site is designated. Other species that contribute to the integrity of the SPA.
High	An impact on a local population of more than 1 % of the national population of a species. An impact on ecologically sensitive species (e.g. rare breeding birds).
Medium	Regionally important population of a species, either because of population size or distributional context, EU Birds Directive Annex 1, EU Habitats Directive priority habitat/species or Species of European Conservation Concern (SPEC) and or Wildlife and Countryside Act Schedule 1 species (if not covered above). UK BAP priority species (if not covered above).
Low	Any other species of conservation interest (e.g. species listed on the Birds of Conservation Concern not covered above).

A species' sensitivity is not just based on its nature conservation value it also depends on the sensitivity of the species to a particular impact. Further refined species specific sensitivity assessment has been undertaken in line with recommendations made in Maclean *et al.* (2009). Sensitivities of species groups to particular impacts are ranked and combined with the nature conservation value to give an overall sensitivity. The main types of impact identified are:

- Collision Mortality,
- Barrier effect,
- Displacement (including disturbance and indirect impacts, i.e. depletion of prey).

Collision Mortality

Collision risk modelling has been undertaken includes the additional data collected up to January 2012 and is based upon the Band *et al.* (2011) model. The results are presented in Appendix A.

Collision risk modelling has been undertaken using twice. One is based on the Rochdale envelope as presented within the Environmental Statement submitted in August 2011 and has been updated to include the additional survey data. Since the submission of the Environmental Statement further information has become available on the potential turbines that may be installed at the test centre. Consequently, some of the parameters in the original Rochdale envelope have been revised and the inputs into the collision risk modelling adjusted to account for these (Table 3-5). A second set of collision risk modelling has been undertaken based on the revised Rochdale envelope. Both sets of results from the collision risk model based on the original Rochdale envelope and the revised Rochdale envelope are presented in Appendix A and A1 and summarised in Table 8-65 and Table 9-66.

Table 3-5: Original and revised Rochdale envelope Turbine parameters used for collision risk modelling.

Parameters	EOWDC turbines (original Rochdale)	EOWDC turbines (updated Rochdale)
Turbine diameter (m)	150	167
No. of turbines	11	11
No. of rotor blades	3	3
Maximum chord width m	6.5	5.4
Mean revolutions per minute (rpm)	7.4	6.05
Operating time	85%	85%
Pitch	30 degrees	15 degrees
Efficiency %	85 %	85%

The risk is assessed based on the probability of a bird flying through the rotor swept area and the probability of it colliding. This is then multiplied by number of flights predicted to occur through rotor swept area based on site specific data; no avoidance behaviour is accounted for.

Data from existing offshore wind farms indicate that there is in fact a significant avoidance of wind turbines, typically greater than 99% (e.g. Pettersson 2005, Petersen *et al*. 2006, Cook *et al*. 2012) and the probability of a bird colliding takes this into account by including an avoidance rate. For the purposes of this assessment a range of avoidance rates have been used to give a range of potential mortality rates. The avoidance rates used are 95%, 98%, 99% and 99.5% based on SNH guidance (SNH 2010a) but it is also noted that Maclean *et al*. (2009) recommended avoidance rates of 99% or greater. However, in order to determine potential effects a precautionary 98% has been used in the first instance, unless there is evidence that the use of a higher or lower avoidance rate may be more appropriate.

Not all species recorded within Aberdeen Bay are at significant risk of collision. The level of risk depends on a large extent as to whether the species frequently flies at rotor height. Birds can fly at any height and may change depending upon weather conditions or behaviour. However, by using data from both site specific boat-based survey data and other extensive data sets from other offshore wind farm locations a large sample size of flight heights are available for collision risk assessment. These have recently been compiled and a model developed to assess flight heights using an extensive data set from a wide range of offshore wind farms (Cook *et al.* 2012).

Collision risk modelling has been undertaken based on site specific data and the results from Cook *et al*. model and results from both sets of modelling are presented.

The site specific data is based on a minimum rotor tip height of 25 m whereas the extensive data modelled in Cook *et al.* (2012) is based on a lower tip height of 20 m. Both these have been considered in the impact assessment. Where the results differ, the worst-case, i.e. the highest predicted number of collisions has generally been used. This allows for a more precautionary assessment.

Species selected for collision risk modelling have been selected on advice received during consultation, their frequency of flying at rotor height (Table 3-6) and the frequency at which they are recorded in Aberdeen Bay (Table 3-2 and Table 3-3). Collision risk modelling was undertaken on the following species:

- Common scoter
- Eider
- Red-throated diver
- Pink-footed goose
- Barnacle goose
- Fulmar
- Gannet
- Cormorant
- Shag
- Common gull
- Herring gull
- Great black-backed gull
- Common gull
- Kittiwake
- Sandwich tern
- Common tern
- Arctic skua
- Guillemot
- Razorbill
- Puffin

Body sizes were obtained from BTO BirdFacts website (BTO 2011).

Annual Mortality Rates were obtained from BTO BirdFacts website (BTO 2011).

Avoidance Rates were obtained from SNH (2010).

Flight speeds were obtained from Pennycuick (1997), Alerstam *et al*. (2007).

Collision risk estimates have not been provided for either Arctic tern or Great skua despite them having been recorded in boat-based surveys. The reason for this is because they were not detected during the snapshot counts in the first phase of boat based survey. The second phase of survey did detect them, but there is insufficient monthly coverage to extrapolate what the yearly density is. Therefore, no collision risk modelling is possible for these two species. Moreover, the reason that Arctic terns were detected in the 2nd year studies is possibly due to the survey being undertaken in closer proximity to the Ythan Estuary colony and therefore outwith the area of risk.

Table 3-6: Flight heights of birds recorded in Aberdeen Bay from two years boat-based surveys.

Species	Sample size	0 - 10 m		10-25 m		25-200 m		> 200 m		% at Rotor Height
		Total	%	Total	%	Total	%	Total	%	
Red-throated diver	191	126	65.96	56	29.31	**9**	**4.71**	0	0.00	4.71
Black-throated diver	3	3	100.00	0	0.00	**0**	**0.00**	0	0.00	0.00
Common scoter	77	56	72.72	19	24.67	**2**	**2.59**	0	0.00	2.59
Velvet scoter	12	5	50.00	7	50.00	**0**	**0.00**	0	0.00	0.00
Common eider	98	84	85.71	13	13.26	**1**	**1.02**	0	0.00	1.02
Long-tailed duck	20	16	80.00	4	20.00	**0**	**0.00**	0	0.00	0.00
Wigeon	28	0	0.00	0	0.00	**28**	**100.00**	0	0.00	100.00
Teal	1	0	0.00	0	0.00	**1**	**100.00**	0	0.00	100.00
Tufted duck	2	0	0.00	0	0.00	**0**	**0.00**	0	0.00	0.00
Goldeneye	2	2	100.00	0	0.00	**0**	**0.00**	0	0.00	0.00
Fulmar	919	868	94.45	45	4.89	**6**	**0.65**	0	0.00	0.65
Manx shearwater	43	33	76.74	10	23.26	**0**	**0.00**	0	0.00	0.00
Gannet	1,403	956	68.14	327	7.77	**120**	**8.55**	0	0.00	8.55
Cormorant	160	139	86.87	18	11.25	**3**	**1.87**	0	0.00	1.87
Shag	126	121	96.03	5	3.96	**0**	**0.00**	0	0.00	0.00
Great skua	30	19	63.33	7	21.21	**4**	**13.30**	0	0.00	13.30
Arctic skua	56	34	60.70	13	23.21	**9**	**16.07**	0	0.00	16.07
Long-tailed skua	1	1	100.00	0	0.00	**0**	**0.00**	0	0.00	0.00
Black-headed gull	6	4	66.67	2	33.33	**0**	**0.00**	0	0.00	0.00
Common gull	761	83	10.91	443	58.21	**234**	**30.75**	1	0.13	30.75
Kittiwake	2,791	1,180	42.27	1,092	39.12	**518**	**18.56**	1	0.03	18.56
Herring gull	1,197	332	27.73	485	40.51	**380**	**31.74**	0	0.00	31.74
Lsr black-backed gull	32	21	65.63	9	28.13	**2**	**6.25**	0	0.00	6.25
Grt black-backed gull	328	76	23.17	116	35.36	**136**	**41.46**	0	0.00	41.46
Common tern	108	62	57.40	43	39.81	**3**	**2.77**	0	0.00	2.77
Arctic tern	151	80	52.98	60	39.73	**11**	**7.28**	0	0.00	7.28
Arctic tern/Com. tern	29	3	10.34	26	89.66	**0**	**0.00**	0	0.00	0.00
Sandwich tern	104	31	29.81	67	64.42	**6**	**5.77**	0	0.00	5.77
Guillemot	1,631	1,568	96.13	51	3.12	**10**	**0.61**	0	0.00	0.61
Razorbill	668	637	95.35	30	4.49	**1**	**0.15**	0	0.00	0.14
Guillemot/Razorbill	561	551	98.22	10	1.78	**0**	**0.00**	0	0.00	0.00
Puffin	169	168	99.40	1	0.60	**0**	**0.00**	0	0.00	0.00
Little auk	17	17	100.00	0	0.00	**0**	**0.00**	0	0.00	0.00
Golden plover	2	2	100.00	0	0.00	**0**	**0.00**	0	0.00	0.00
Oystercatcher	1	0	0.00	0	0.00	**1**	**100.00**	0	0.00	100.00
Dunlin	3	3	100.00	0	0.00	**0**	**0.00**	0	0.00	0.00
Curlew	2	2	100.00	0	0.00	**0**	**0.00**	0	0.00	0.00
Gadwall	1	1	100.00	0	0.00	**0**	**0.00**	0	0.00	0.00

Species	Sample size	0 - 10 m		10-25 m		25-200 m		> 200 m		% at Rotor Height
		Total	%	Total	%	Total	%	Total	%	
Mallard	1	0	0.00	1	100.00	**0**	**0.00**	0	0.00	0.00
Shelduck	5	5	100.00	0	0.00	**0**	**0.00**	0	0.00	0.00
Barnacle goose	831	314	37.79	220	26.47	**64**	**7.70**	233	28.04	0.00
Goose *sp.*	85		0.00	0	0.00	**25**	**29.41**	60	70.59	0.00
Meadow pipit	7	7	100.00	0	0.00	**0**	**0.00**	0	0.00	0.00
Swift	1	1	100.00	0	0.00	**0**	**0.00**	0	0.00	0.00
Skylark	1	1	100.00	0	0.00	**0**	**0.00**	0	0.00	0.00

Flight heights were collected as being between 0 m and 10 m, between 10 m and 25 m and greater than 25 m. Those between 25 m and 200 m have been considered to be at risk of collision. It is not possible to produce frequency plots of flight heights from these data but existing published data from other offshore developments have been used to put these figures into a wider context using a much larger data set than the data collected from Aberdeen Bay.

Collision impacts are not predicted to occur during either the construction or decommissioning phases as the turbine blades are not rotating and are therefore not assessed for these periods.

Species sensitivities are based on the results from the collision risk modelling and the adult survival rates (Table 3-7) combined with the nature conservation value (Table 3-4) to give an overall sensitivity presented in Table 3-8.

Herring gulls have a high sensitivity to collision risk based on adult survival alone but also have a relatively high proportion recorded at rotor height. Consequently, for the purposes of this assessment they are considered to be of very high sensitivity (Furness and Wade 2012).

Table 3-7: Sensitivity of population to collision risk based on adult survival.

Sensitivity	Definition
Very High	Annual Survival > 0.90 – Fulmar, Gannet, Manx shearwater, Barnacle goose, Eider, Auks, Kittiwake, Lesser black-backed gull, Great black-backed gull, Black-headed gull, Common tern, Arctic tern, Herring gull.
High	Annual Survival 0.85 – 0.90 – Cormorant, Shag, Pink-footed goose, greylag goose, Shelduck, Skuas, Common gull, Sandwich tern, Little tern
Medium	Annual Survival 0.80 – 0.85 – Divers, Swans,
Low	Annual Survival <0.80 Ducks, Grebes [(1)] Waders

Source: BTO Birdfacts (2011) 1 = Abt and Konter (2009)

Table 3-8: Overall sensitivity of species to collision.

Nature Conservation Value	Sensitivity of Receptor to collision risk			
	Very High	High	Medium	Low
Very High	Very High	Very High	High	Medium
High	Very High	High	High	Medium
Medium	Very High	High	Medium	Low
Low	High	Medium	Low	Low

Barrier Effect

Barrier effects may arise should the species avoid flying through the proposed development and in doing so incur additional energetic costs required to fly the extra distance around the turbines (Speakman, Gray and Furness 2009; Masden *et al.* 2010). The risk of an impact is largely dependent on the number of times a bird may have to cross the obstruction and also the individual's fitness. Should a bird be required to avoid an area only once or twice a year, for example when undertaking a migration then it is likely that the potential impact will be lower than if a bird regularly flies around a barrier, e.g. between a feeding or roosting site (Speakman, Gray and Furness 2009).

In order to assess the potential impacts from barrier effect it was assumed that, unless data from other wind farms indicates otherwise, all individuals avoided flying through the site and detoured around it and by doing so had to fly further than would have otherwise been the case. To calculate the potential length of detour it was assumed that the detour started 1 km in front of the proposed development and the bird detoured back on to the original course 1 km beyond the proposed development. The original distance the bird would have flown if had not detoured is subtracted from the additional distance the bird has flown to get a figure for the potential increase in distance travelled. However, it is also recognised that some birds may start to detour at greater distance than 1 km and others may not and some may not detour at all.

It was assumed that all flights were potentially along the longest axis, i.e. north-south and therefore of greatest effect.

The total length of the proposed development is approximately 4 km and the width 2 km. The distance flown in order to avoid the proposed development from 1 km all round is 7.2 km. Therefore, the incremental increase in flight distance caused by flying around the proposed development is 3.2 km.

Where appropriate, results from energetics modelling have been considered to assess the potential incremental increase in daily energy expenditure (Speakman, Gray and Furness 2009).

Barrier effects are predicted to occur once the turbines are installed and although they may occur at the end of the construction period or beginning of the decommissioning periods when turbines are still in situ. These effects will be for a relatively short duration compared to the overall duration of those phases and therefore barrier effects are not assessed during these stages.

To assess the potential sensitivity of a species to a barrier effect a species specific sensitivity, based on wing loads (Table 3-9), combined with nature conservation value (Table 3-4), have been used to provide an overall sensitivity (Table 3-10).

Table 3-9: Species sensitivity due to barrier effects.

Sensitivity	Species
Very High	Black-throated diver
High	Red-throated diver
Medium	Ducks,
Low	Fulmars, Skuas and Gulls Gannets, Terns, Waders and Passerines

Table 3-10: Overall sensitivities due to barrier effect.

Nature Conservation Value	Species Sensitivity due to barrier effects			
	Very High	High	Medium	Low
Very High	Very High	Very High	High	Medium
High	Very High	Very High	High	Medium
Medium	Very High	High	Medium	Low
Low	High	Medium	Low	Low

Displacement

Displacement caused by the proposed EOWDC may lead to birds avoiding potential feeding areas, resulting in effective habitat loss. This may be caused by a number of reasons. Displacement may be caused by disturbance from vessels associated with the proposed development or from secondary impacts, i.e. the depletion of prey in the development area. For some species it is not known why displacement occurs. However, whatever the cause, the effects are the same; birds are displaced from an area and relocate to another area. The significance of the displacement is difficult to quantify but for species that rely on localised or patchy food supplies the effect may be more significant than it is for species that have a wide range of food sources over a wide area. Based on the Maclean *et al.* (2009) and Furness and Wade (2012) reports, the impact assessment has considered sensitivity of a species depending on its habitat flexibility, i.e. how restricted the species is to a particular habitat (Table 3-11). Potential impacts relating to disturbance by vessels are addressed in the species accounts.

The overall sensitivity is based on the species specific and nature conservation value (Table 3-12).

Table 3-11: Species sensitivity due to displacement.

Sensitivity	Species
Very High	Red-necked grebe, Divers, Scoter, Goldeneye, Eider, Little tern, long-tailed duck,
High	Cormorant, Shag, Great-crested Grebe Auks Common tern, Arctic tern, Sandwich tern
Medium	Little gull, Great black-backed gull, Kittiwake, Great skua
Low	Black-headed gull, Gannet, Lesser black-backed gull, Herring gull, Fulmar.

Table 3-12: Overall sensitivity due to displacement.

Nature Conservation Value	Species Sensitivity due to displacement effect			
	Very High	High	Medium	Low
Very High	Very High	Very High	High	Medium
High	Very High	Very High	High	Medium
Medium	Very High	High	Medium	Low
Low	High	Medium	Low	Low

For the purposes of the assessment assumptions have been made as to the level of displacement that may occur based on Langston (2010) and Maclean *et al* (2009). For all key species the assessment assumes that there is a range of displacement within the proposed EOWDC area and out to 2 km beyond the furthest turbine.

The proportion of birds displaced is based on their reported sensitivity (very high, high, medium or low and a range of potential displacement is presented for each category.

- Very high/high >70%
- Medium 40% to 60%
- Low < 30%

In order to determine potential scale of impact the maximum recorded density obtained from any location from any of the boat-based surveys has been used in the assessment. This provides a precautionary assessment for the potential numbers of birds displaced, as for the majority of species peak densities were recorded outwith the proposed development area.

Magnitude of effect

The magnitude of effect for potential displacement and collision mortality is based on the definitions developed by Percival (1999) (Table 3-13). However, this is not suitable for determining the potential magnitude arising from barrier effect and consequently the assessment of the potential magnitude of barrier effects is based on Maclean *et al.* (2009) (Table 3-14).

Table 3-13: Definition of potential magnitude of an effect.

Magnitude	Definition
Very High	Potential total loss or very major alteration to key elements/features of the baseline conditions such that post development character/composition/ attributes will be fundamentally changed and may be lost from the site altogether. Guide: >80% of population/habitat lost.
High	Potential for major alteration to key elements/ features of the baseline (pre-development) conditions such that post development character/composition/attributes will be fundamentally changed. Guide: 20-80% of population/habitat lost.
Medium	Potential for loss or alteration to one or more key elements/features of the baseline conditions such that post development character/ composition/ attributes of baseline will be partially changed. Guide: 5-20% of population/habitat lost.
Low	Potential for a minor shift away from baseline conditions. Change arising from the loss/ alteration will be discernible but underlying character/ composition/ attributes of baseline condition will be similar to pre-development circumstances/patterns. Guide: 1-5% of population/habitat lost.
Negligible	Potential for a very slight change from baseline condition. Change barely distinguishable, approximate to the "no change" situation. Guide: <1% of population/habitat lost.

Table 3-14: Criteria used to determine the magnitude of impact due to barrier effect.

Magnitude of impact	Definition
Very High	(i) Wind farm is located between breeding site and key foraging area of a species flying through the site in nationally or internationally important numbers and/or (ii) is located close to key stopover, breeding or wintering site of species flying through the site in internationally important numbers and/or (iii) is located along the migration route of a species flying through the site in internationally important numbers.
High	(i) Wind farm is located close to key stopover, breeding or wintering site of species flying through the site in nationally important numbers and/or (ii) is located along the migration route of a species flying through the site in nationally important numbers.
Medium	(i) Wind farm is located between breeding site and key foraging area of a species flying through the site in regionally important numbers (ii) is located close to key stopover, breeding or wintering site of a species flying through the site in nationally important numbers (ii) Is located along the migration route of a species flying through the site in regionally important numbers.
Low	(i) Wind farm is located between breeding site and key foraging area of any other breeding species and/or (ii) is located close to a key stopover, breeding or wintering site of any other species and/or (iii) likely to be located on a migration route of any other species.
Negligible	None of the above

By using the overall sensitivity of a receptor and the potential magnitude of effect, an indicative overall significance of the impact to the receptor is obtained (Table 3-15). However, it is recognised that this is only indicative and evidence from existing wind farms and judgement is used to determine whether the potential impact is likely to be either significant or adverse.

Table 3-15: Potential significance of impact.

Magnitude	Overall Sensitivity of Receptor			
	Very High	High	Medium	Low
Very High	Major	Major	Major	Moderate
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Moderate	Minor
Low	Moderate	Minor	Minor	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

The duration of an impact can also affect the overall significance of an effect and should be defined in relation to relevant ecological characteristics, e.g. species lifecycles (IEEM 2010). For the purposes of this assessment temporal scales have been defined based up on the lifecycles of seabirds.

Table 3-16: Temporal scales of significance.

Significance of Impact	Description
Permanent	Greater than thirty years. Equivalent to multiple generations.
Long-term	Five to thirty years. This is within the range of life expectancy for most seabirds and the equivalent of at least one or more generations.
Medium-term	One to five years This is within the range of first breeding for most seabirds.
Short-term	Less than one year. This equivalent to one breeding season.

Definitions of what may be considered significant are provided in Table 3-17. The determination of significance is based on the species sensitivity and magnitude of the potential impact.

Table 3-17: Definition of significance.

Major	Population level effects will be detectable and have the potential to cause a significant effect or an adverse effect on the conservation status of the qualifying species.
Moderate	Population level effects will be detectable and have the potential to cause an effect on the population or the conservation status of the qualifying species.
Minor	Changes in the population may be detectable but not likely to cause significant effects on the population of the species or its conservation status.
Negligible	No detectable changes in the populations and no likely significant effects on the conservation status of qualifying species. The potential impact is not of concern.

Implications of significance

Where the potential significance is identified as being negligible or minor, the effect will not be significant. A finding of moderate significance has the potential to be either significant or not significant. A moderate finding will be subject to a further detailed review to determine whether or not the effect would be significant in terms of the Regulations or not. A finding of major significance will result in a significant effect in terms of the Regulations.

It should be noted that the significance derived at is only a guide and the final conclusions of the impact assessment for each species is drawn upon the currently available evidence for each species.

Determining potential adverse effects

To determine potential adverse effects the assessment is based on the Conservation Objectives and qualifying species of the site (see Section 4.4).

To identify whether an impact is potentially adverse with respect to potential impacts on population levels a measure based upon the 1% of baseline mortality rate has been used as a guide. This guidance is based on an EC Report on the application of the Birds Directive and although does not relate specifically to impacts from wind farms it does provide guidance against which an assessment can be made (EC 2000). If there is an increase in the baseline mortality rate of more than 1% then there is the potential for an adverse effect. However, it is recognised that for populations that may not be in favourable status an increase in baseline mortality rate of less than 1% may still cause an adverse effect.

In order to determine whether there is the potential for an adverse effect the SPA population of the species has to be determined. Population levels can increase or decrease often by natural change. Consequently, the population within the SPA citation may not be comparable with the more recent counts and by making an assessment against historical population levels as published in the sites citation an inaccurate conclusion may be drawn. For the purposes of this assessment the latest SPA population figures have been used, although it is recognised that the population at the time of citation may still be relevant. The figures have been obtained from SNH and JNCC sources (SNH 2011b, JNCC 2011a) (Table 3-19).

For many species of bird present in Aberdeen Bay it is likely that birds of the same species may be from different SPA sites, e.g. guillemots may be from Fowlsheugh SPA, Troup, Pennan and Lion's Head SPA and Buchan Ness to Collieston SPA. It is not possible to identify from which specific SPA the birds present within Aberdeen Bay are from. Where possible, assumptions have been made on the proportion of birds that may be present based on the distance each SPA is from the proposed development although the assessment may, on occasions, assume that birds potentially at risk of an impact are all from a single SPA.

The estimation of the number of birds potentially impacted from each of the relevant colonies is based on the number of colonies potentially at risk of an impact and the distance each of the colonies is from the proposed development area. The number of birds predicted to be impacted is then apportioned to each of the colonies depending on distance, with those closer to the EOWDC having a proportionally greater number of birds at risk than those further away.

Ultimately the approach to ascertaining whether there is a potential adverse effect on site integrity is a judgement based on the totality of the evidence available.

3.6 Assessment of cumulative impacts

The assessment of cumulative impact considers all other activities that have the potential to significantly impact on the birds that may be present at the proposed development location, these possible activities include:

- Offshore renewables,
- Shipping,
- Aggregates,
- Dredging,
- Oil and gas,

- Recreational activities,
- Fishing.

Offshore renewable projects that have been identified as having the potential for a cumulative effect include two developments in the Moray Firth and three in the Firth of Forth. The sites in the Moray Firth are approximately 150 km to the north and those in the Firth of Forth approximately 120 km to the south of the proposed development (Table 3-18).

The construction of the EOWDC is planned for 2013 and 2014 and so there is the potential for an overlap in construction activities in 2014 with Neart Na Gaoithe and Beatrice offshore wind farms. However, given the stage of development of the renewable projects yet to be constructed and the uncertainty as to the types of foundations and turbines that will be used, there is sparse information available to incorporate into any impact assessment, which limits the effectiveness of cumulative assessments considering conceptual projects yet to be subject to a formal planning application and for which no environmental or design data are currently available.

Therefore, the cumulative impact assessment can only be undertaken with data available from the currently operating Beatrice demonstrator project in the Moray Firth and the recently published Beatrice Offshore Wind Farm also in the Moray Firth (BOWL 2012). Although, the assessment does, wherever possible, take into account the potential cumulative impacts from other renewable projects.

There are numerous onshore wind farms in Aberdeenshire and there is the potential for cumulative impacts from these developments on certain species that occur both onshore and offshore, e.g. Geese and Gulls. Where relevant information is available these potential impacts have also been considered.

Impacts from shipping associated with Aberdeen harbour has been assessed in Chapter 15 of the Environmental Statement (as submitted in August 2011). Shipping has been undertaken in Aberdeen Bay over many centuries with currently approximately 16,000 vessel movements per year. There are no known plans that are likely to cause a significant increase in the level of shipping currently being undertaken in Aberdeen Bay and any impacts shipping may currently be having on the birds within Aberdeen Bay will be part of the baseline.

There are no aggregates activities within Aberdeen Bay. There are no licensed dredging sites within Aberdeen Bay but occasional dredging of the harbour may occur, with the next dredging scheduled for 2012.

Aside from associated shipping there are no oil and gas related activities within Aberdeen Bay.

Recreational activities within Aberdeen Bay are described in Chapter 23 of the Environmental Statement (as submitted in August 2011). The main potential for a cumulative impact is considered to arise mainly from yachting with many recreational vessels following an inshore route from the Forth to Peterhead and vice versa, often at night to take advantage of favourable tidal flows. The numbers of recreational vessels using Aberdeen Bay are unknown. However, the level of impact caused by recreational activities has been on-going for many years and the disturbance that this may cause to birds in Aberdeen Bay is part of the baseline environment. It is predicted that the presence of the EOWDC will not cause any greater level of recreational activity in Aberdeen Bay than is already present and although the scale of the activity is unquantified the presence of the proposed development will not likely cause a significant increase in vessels detouring into nearshore waters to a level that could cause a significant impact on the birds present. No cumulative impacts are predicted to occur over and above the current levels of disturbance.

Fishing activity within Aberdeen Bay is described in Chapter 21 of the Environmental Statement (as submitted in August 2011). The level of fishing activity within the bay is relatively low and few vessels occur within the area of the proposed development. The presence of the proposed EOWDC is not predicted to increase the level of fishing activity in the area and consequently the cumulative impact from fishing will be no greater than the current levels of impact, which are part of the baseline conditions.

Table 3-18: Potential renewable energy developments on east coast of Scotland.

Name of development	Developer	MW	Possible number of Turbines	Project timeframe construction
The Beatrice Demonstrator	Joint Venture Talisman and Scottish and Southern Energy	10	2	Installed operational
The Moray Firth Eastern Development	Moray Offshore Renewables Ltd	1,300	*c.*200	2015
The Moray Firth Western Development			Not yet known	Unknown >2015
Beatrice	Sea Energy Renewables Ltd and Scottish and Southern Energy	920	184	2014
Firth of Forth: Phase 1	SeaGreen	1,075	215	2016
Firth of Forth: Phase 2		1,435	287	2019
Firth of Forth: Phase 3		955	191	2020
Neart na Gaoithe	Mainstream Renewable Power	420	130	2015
Inch Cape	SeaEnergy	905	181	2016

3.7 Assessment of in-combination impacts

The Conservation (Natural Habitats, and c.) Regulations 1994 (as amended) require that a Habitats Regulations Appraisal (HRA) must be conducted by a competent authority. The HRA considers the implications for European sites in view of the European sites conservation objectives (See section 3.4), in respect of any plan or project which is not directly connected with or necessary to the management of the European site for conservation purposes and which is likely to have a significant effect on the European site either alone or *in-combination* with other plans or projects.

Therefore the term ‘in-combination’ will be used when considering the impacts of the proposals with other plans or projects on European sites and their associated qualify features or species.

The main industries considered for potential in-combination impacts are proposed offshore wind farms, aggregate industry, dredging, oil and gas and shipping. Of these, proposed offshore wind farms and shipping are the only activities identified for which there is a potential for an in-combination impact.

Table 3-19: National, Scottish and Regional SPA species populations.

Species	Season	National Pop^{n}	Scottish Pop^{n}	Regional SPA Pop^{n}	1% regional SPA Pop^{n}
Whooper swan	Summer	<15 *p.*	3-7 *p.*	0	0
	Winter	10,678 *i.*	4,142 *i.*	330	3 *i.*
Red-throated diver	Summer	1,014 – 1,551 *p.*	1,000 – 1,500 *p.*	0	0
	Winter	17,000 *i.*	2,270 *i.*	317 *i.* [1]	3 *i.* [1]
Fulmar	Summer	530,000 Aon	486,000 Aon	6,418 Aon	128 *i.*
	Winter	-	-	-	-
Northern gannet	Summer	230,000 Aon	182,511 Aon	51,647 Aon	1,032 i
	Winter	-	-	-	-
Manx shearwater	Summer	277,803 – 311,263 *p.*	126,545 Aon	0	0
	Winter	0	0	0	0
Great cormorant	Summer	8,400 *p.*	3,600 Aon	198 *p.*	3 *i.*
	Winter	23,000 *i.*	9 – 11,000 *i.*	-	-
European shag	Summer	27,000 Aon	21,500 – 30,000 Aon	3,218 *p.*	64 *i.*
	Winter	-	60,000 – 80,000 *i.*	-	-
Pink-footed goose	Summer	0	0	0	0
	Winter	340,000 *i.*	200,000 *i.*	348,000 *i.*	3,480 *i.*
Greylag goose	Summer	35,177	25,000 *i.*	0	0
	Winter [2]	83,677	85,000 *i.*	6,529 i	65 *i.*
Barnacle goose (Svalbard pop^{n})	Summer	0	0	0	0
	Winter	32,000 *i.*	32,000 *i.*	2,200 *i.*	22 *i.*
Shelduck	Summer	11,000 *i.*	1,750 *p.*	-	-
	Winter	78,000 *i.*	70,000 *i.*	5,268 *i.*	53 *i.*
Eurasian wigeon	Summer	400 *p.*	240 – 400 *p.*	-	-
	Winter	359,236 *i.*	76,000 – 96,000 *i.*	6,083 *i.*	61 *i.*
Eurasian Teal	Summer	<2,050 *p.*	1,950 - 3,400 *p.*	-	-
	Winter	192,000 *i.*	22,500 – 125,000 *i.*	504 *i.*	5 i
Mallard	Summer	48,000 – 114,000 *p.*	17,000 – 43,000 *p.*	-	-
	Winter	352,000 *i.*	65,000 – 90,000 *i.*	2,546 *i.*	25 *i.*
Goldeneye	Summer	200 *p.*	125 – 150 *p.*	-	-
	Winter	25,000 *i.*	10,000 – 12,000 *i.*	836 *i*	8 *i.*
Common eider	Summer	31,000 *p.*	20,000 *p.*	1,500 *p.*	30 *i.*
	Winter	73,000 *i.*	64,500 *i.*	9,000 *i* [1]	90 *i.* [1]
Long-tailed duck	Summer	0	0	0	0
	Winter	16,000 *i.*	15,000 *i.*	<100 *i.* [1]	1 *i.* [1]
Common scoter	Summer	9 – 52 *p.*	9 – 52 *p.*	6,500 *i.* [1]	65 *i.*
	Winter	50,000 – 65,000 *i.*	25,000 – 30,000 *i.*	2,187 *i*	22 i.
Velvet scoter	Summer	0	0	600 *i.* [1]	6 i.
	Winter	3,000 *i.*	2,500 – 3,500 i	-	-
Red-breasted Merganser	Summer	2,400 *p.*	2,000 *p.*	80 *i* [1]	<1 [1]
	Winter	10,200 *i.*	8,500 i	-	-
Guillemot	Summer	1,300,000 *i.*	780,000 *p.*	86,187 *i*	861 *i.*

GENESIS

Species	Season	National Pop[n]	Scottish Pop[n]	Regional SPA Pop[n]	1% regional SPA Pop[n]
	Winter	-	750,000 *i.*	-	-
Razorbill	Summer	110,000 *p.*	93,300 *p.*	12,275 *i.*	123 *i.*
	Winter	-	50,000 – 250,000 i	-	-
Atlantic puffin	Summer	579,000 *p.*	493,000 *p.*	58,867 Aon	1,177 *i.*
	Winter	-	20,000	-	-
Great skua	Summer	9,650 *p.*	9,650 *p.*	-	-
	Winter	0	0	0	0
Arctic skua	Summer	2,100 *p.*	2,100 *p.*	-	-
	Winter	0	0	0	0
Black-headed gull	Summer	130,000 *p.*	43,200 Aon	-	-
	Winter	2,200,000 *i*	150,000 *i.*	-	-
Common gull	Summer	48,000 *p.*	48,100 *p.*	-	-
	Winter	620,000 – 721,000 *i.*	79,700 *i.*	-	-
Herring gull	Summer	131,000 Aon	72,000 Aon	-	-
	Winter	450,000 *i.*	91,000 *i.*	9,801 *p.*	196 *i.*
Lesser black-backed gull	Summer	110,000 *p.*	25,000 Aon	2,920 *p.*	58 *i.*
	Winter	118,000 – 131,000 *i.*	200 – 600 *i.*	-	-
Great black-backed gull	Summer	17,000 *p.*	14,800 Aon	-	-
	Winter	71,000 – 81,000 *i.*	7,500 – 10,000 *i*	-	-
Black-legged kittiwake	Summer	370,000 *p.*	282,200 Aon	48,894 *p.*	818 *i.*
	Winter	-	10,000 *i.*	-	-
Little tern	Summer	1,900 *p.*	331 Aon	36 *p.*	<1 *i.*
	Winter	0	0	0	0
Sandwich tern	Summer	11,000 *p.*	1,100 Aon	645 *p.*	13 *i.*
	Winter	0	0	0	0
Common tern	Summer	10,000 *p.*	4,800 Aon	384 *p.*	8 *i*
	Winter	0	0	0	0
Arctic tern	Summer	52,600 *p.*	47,300 *p.*	903 *p.*	18 *i*
	Winter	0	0	0	0

(1) = Non SPA species in Aberdeen Bay; (2) = Icelandic wintering population of greylag goose

Sources: BTO 2011, Calbrade *et al.* 2010; Forrester *et al* 2009, North East Scotland Bird Reports (NESBR)

p. = pairs; *i.* = individuals; Aon = Apparently occupied nests

4.0 SPECIES ASSESSMENTS

4.1 Whooper swan (*Cygnus cygnus*)

4.1.1 Protection and Conservation Status

The whooper swan is listed in Annex I of the Birds Directive, Appendix II of the Bern Convention, Appendix II of the Bonn Convention, Schedule 1 under the Wildlife and Countryside Act, 1981 and is on the Amber List of Species of Conservation Concern.

4.1.2 Background

Whooper swan		
GB Population	Breeding: <15 prs. Winter: 10,678 ind.	Holling 2010 Calbrade *et al*. 2010
Scotland	Breeding: 3 – 7prs. Winter: 4,142 ind.	Forrester *et al.* 2007
International threshold	210 ind.	Calbrade *et al*. 2010
GB threshold	57 ind.	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	Loch of Strathbeg: 333 ind.	SNH 2011b JNCC 2011a
European population estimate	Breeding: 16,000 – 21,000 Wintering: >65,000	Birdlife 2004
European population trend	Status: 'Large increase' Trend: 'secure'	Birdlife 2004
World population	180,000 'adults'	Birdlife 2011

Whooper swans are a rare breeding bird in the UK and Scotland with less than 15 pairs nesting each year, approximately half of which nest in Scotland. Wintering birds arrive from their main breeding grounds in Iceland during October and November and spend the winter on lowland farmland, lochs and marshland (Forrester et al. 2007). In North-east Scotland small numbers of whooper swans can occur in many of the freshwater lochs but the main wintering area is the Loch of Strathbeg where over 300 whooper swans have occurred in recent years, although up to 600 were present there in the early 1980's (Buckland, Bell and Picozzi 1990).

Satellite tagging studies have indicated that the majority of whooper swans migrating along the east coast are associated with the wintering sites in East Anglia but no birds were recorded flying along the North-east coast of Scotland with birds crossing the Firth of Forth moving predominantly north-west/south-east direction (Griffin, Rees and Hughes 2010).

Boat-based surveys

Ten whooper swans were recorded during boat-based surveys undertaken in Aberdeen Bay on 24 March 2011.

Vantage Point surveys

No whooper swans were recorded from any of the vantage point surveys undertaken between March 2006 and March 2008 (EnviroCentre 2007; Alba Ecology 2008a, b).

Bird Detection Radar

No whooper swans were recorded during any of the radar studies undertaken.

4.1.3 Summary of Results

No whooper swans were recorded from vantage point or radar studies and only one flock of ten birds were recorded on the sea surface during boat-based surveys.

4.1.4 Species Sensitivities

Qualifying species

There are twenty Special Protection Areas (SPA) in the UK for which whooper swan is a qualifying species, of which one is within an area of potential impacts from the proposed development:

- Loch of Strathbeg SPA and Ramsar (47.6 km).

Formerly whooper swan was also a qualifying feature for the Loch of Skene SPA and under the last review, the Loch of Skene held 307 whooper swan based on the 5 year peak mean from between 1991/92 and 1995/96 (Stroud *et al.* 2001). Recent counts at Loch of Skene indicate a decline in the use of the site by whooper swans with peak counts of 72 in 2008 (NESBR).

The Loch of Strathbeg review reported 183 whooper swans (3.3% of the wintering population in Great Britain) based on the 5yr peak mean from between 1991/92 and 1995/96 (Stroud *et al.* 2001). More recent data have recorded a five year peak mean of 298 whooper swans with the latest published counts being of 182 in 2009 (Holt *et al*. 2011).

Flight height

The median flight height for whooper swans across the Moray Firth is 1 m with 83% of flights at or below 20 metres and 100% of flights below 50 m. Elsewhere, recorded flight height have been higher, e.g. across the Wash the median flight heights are higher at 30 m with 22% below turbine height (Griffin, Rees and Hughes 2010). Overall, the mean flight height of whooper swans migrating overland is 82 m (±9 m) and over water is 31 m (±3 m) (Griffin, Rees and Hughes 2011).

Collision risk

Site specific monitoring using both boat-based and land-based surveys and radar studies indicate that whooper swans are infrequent within the area of the proposed development with no sightings within the footprint of the proposed development and only one sighting of ten birds on the sea. Data from satellite tagging studies indicates a relatively low usage of the North-east coast of Scotland by whooper swans on passage, with the majority of birds flying overland (Griffin, Rees and Hughes 2010; Griffin, Rees and Hughes 2011).

Monitoring from existing offshore wind farms indicate that migrating whooper swans will, if migrating along the coast, remain in nearshore waters. Nearly 90% of migrating whooper swans in Liverpool Bay were recorded within 2.5 km of the coast, with 70% along the coastline (RBA 2005).

Flight height data obtained from radio tracking studies suggest that the mean flight height is approximately 30 m (Griffin, Rees and Hughes 2011). Monitoring results from existing wind farms indicate that 70% of whooper swans fly below 30 m (RBA 2005).

Based on the monitoring results from existing offshore wind farms and site specific data indicating a very low and infrequent usage of the area by whooper swans, the risk of any significant impact or adverse effect on whooper swans from collision mortality is negligible.

Barrier effect

Studies undertaken in Sweden suggest that Swans (including whooper swan) and Geese may avoid flying into wind farms during migration (Pettersson 2005).

In order to avoid the turbines the birds may incur additional energetic expenditure. The proposed EOWDC is at its longest point approximately 4 km and at its widest 2 km. Assuming birds avoid the wind farm at 1,000 m then they may incur an overall increase in flight distance of 3.2 km. For whooper swans flying to, or from, Iceland, a distance of over 1,000 km, the potential increase in distance flown in order to avoid the turbines is less than 0.3% of total flight distance and the potential impacts temporally long-term, the magnitude negligible and potential effects not significant.

Displacement

Although the only sighting from surveys was of birds on the sea surface, generally Whooper swans rarely settle on the sea surface and tend to do so only in poor weather during periods of migration (Griffin, Rees and Hughes 2010). Whooper swans do not forage offshore (Snow and Perrins 1998) and therefore there will not be any significant displacement of whooper swans due to the proposed development.

Cumulative and in-combination

The very low level of usage of the site indicates that there will not be any cumulative or in-combination impacts.

Table 4-1: Summary of the significance of potential impacts on whooper swan.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Medium	Negligible	Medium	Negligible
Operation	Collision	High	Negligible	Long-term	Negligible
	Displacement	Medium	Negligible	Long-term	Negligible
	Barrier	High	Negligible	Long-term	Negligible
Decommissioning	Displacement	Medium	Negligible	Medium	Negligible
Cumulative	All	High	Negligible	Long-term	Negligible

4.1.5 Conclusions

Habitats Appraisal

Based on the available evidence from site specific surveys undertaken at the proposed development area and the very low usage of the site during migration and that the Loch of Strathbeg SPA is located to the north and therefore birds wintering at this site and migrating to or from Iceland will not cross the proposed development area. It is concluded that the proposed development will not have an adverse effect on whooper swans as a qualifying feature for Loch of Strathbeg SPA.

Environmental Impact Assessment

Based on the low numbers of whooper swans recorded at the proposed development area and the known behaviour of Swans, it is predicted that there will not be a significant environmental effect arising from the proposed development on whooper swans.

4.2 Pink-footed goose (*Anser brachyrhynchus*)

4.2.1 Protection and Conservation Status

The Pink-footed goose is listed in Appendix II of the Bern Convention, Appendix II of the Bonn Convention and is on the Amber List of Species of Conservation Concern.

4.2.2 Background

Pink-footed goose		
GB Population	Winter: 355,177 ind.	Holt *et al.* 2011
Scotland Population	Winter: 200,000 ind.	Forrester *et al.* 2007
International threshold	2,700 ind.	Holt *et al.* 2011
GB threshold	3,600 ind.	Holt *et al.* 2011
Designated east coast sites where species is a noted feature	Ythan Estuary, Sands of Forvie and Meikle Loch: 25,000 (2008) Loch of Strathbeg: 60,626 (09/10) Firth of Forth: 3,220 (08/09) Firth of Tay and Eden Estuary: 4,342 (5yr peak mean) Montrose Basin: 38,911 (08/09)	Calbrade *et al*. 2010 Holt *et al.* 2011 NESBR
European population estimate	Breeding: 50,000 – 69,000 pairs Wintering: >290,000 ind.	Birdlife 2004
European population trend	Status 'secure' Trend 'large increase'	Birdlife 2004
World population	310,000 'adults'	Birdlife 2011

The pink-footed goose population that winters in the UK breed in Iceland and eastern Greenland. They migrate to the UK in the autumn in large numbers during September and October and winter in eastern Scotland, north-west England and Norfolk and start returning north in March and April (WWT 2007; NESBR). In North-east Scotland pink-footed geese are widespread occurring across the region from September through to April. Peak numbers occur in mid-October when pink-footed geese arrive from their breeding grounds during which time up to 25% of the British population may occur at the Loch of Strathbeg and Meikle Loch (NESBR; Holt *et al*. 2011). Birds disperse southward for the winter and return again in March when birds overwintering to south of the region migrate northwards. Between October and March the number of pink-footed geese in the region is lower but those that remain feed on farmland and roost in large numbers on a few freshwater lochs, primarily Loch of Strathbeg, Loch of Skene and Meikle Loch (NESBR).

Birds flying offshore peak during September and October with up to 800 birds per month past Peterhead with numbers dropping in November and December when less than 100 birds per month have been recorded. There is a smaller passage of pink-footed geese past Peterhead during April when 200 birds per month were recorded. Sightings were of birds out to 3 km from shore (Innes 1996).

The pink-footed goose population has increased substantially in recent decades from approximately 50,000 in the 1960s to a present day total of approximately 340,000 individuals; this increase has been reflected in the number of birds occurring in North-east Scotland where the previous population totals used to be only 1,000 to 2,000 birds, increasing to over 50,000 in recent years (Buckland, Bell and Picozzi 1990; Calbrade *et al.* 2010; Holt *et* al. 2011; NESBR).

Boat-based surveys

No pink-footed geese were recorded during any of the boat-based surveys undertaken between February 2007 and April 2008 and again from August 2010 and August 2011 (SMRU 2011b; SMRU 2011c).

Vantage Point surveys

In Aberdeen Bay, pink-footed geese were recorded from four vantage point sites between October and March. There was only one record of three birds in September and no records of pink-footed geese during April. Counts were of a relatively small number of skeins comprising of between 18 and 230 individuals; only three skeins of pink-footed geese were recorded between October and March 2006. The majority of sightings were of birds between 1-3 km from the coast and between 50% and 100% of were flying between 30 m–150 m (Alba Ecology 2008a).

Bird Detection Radar

During radar studies undertaken in October 2005 a total of 12 skeins of pink-footed geese were recorded totalling 858 birds. All sightings were made from Drums with no records from Easter Hatton (Walls *et al*. 2006). Birds were recorded out to 3.0 km with the majority within 500 m from shore (Figure 4-1).

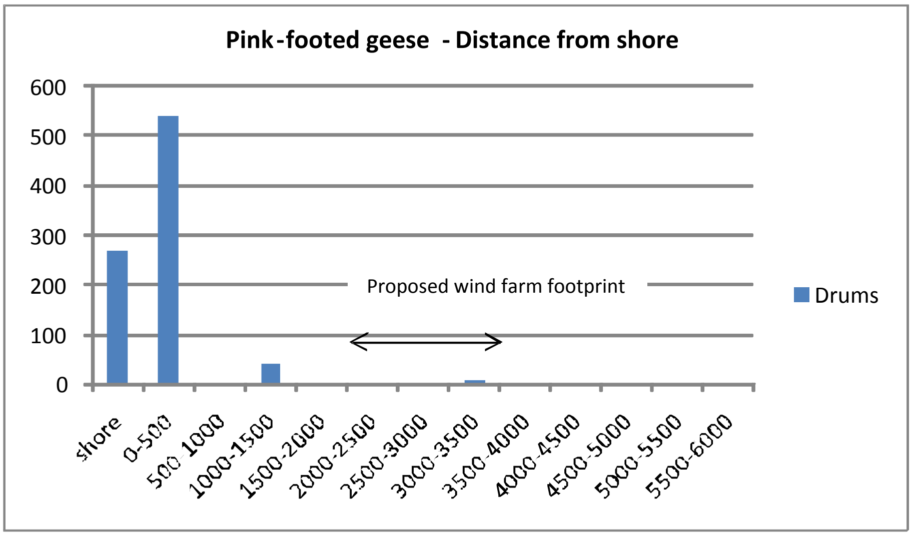


Figure 4-1: Number of pink-footed geese and distance from shore observed from surveys at Drums in October 2005 (Adapted from Walls *et al*. 2006).

Seventeen days of radar studies recorded 102 pink-footed geese in four skeins flying north between 11 April and 26 April 2007. All sightings were from between 0.5 km and 2 km from shore and below 30 m (Simms *et al.* 2007*).* A further radar study aimed to detect migrating geese across Aberdeen Bay during six days in April 2010 recorded three skeins of geese, one of which was confirmed to be pink-footed geese. All three skeins were moving northwards and the one skein that was visually observed was of 90 birds (Plonczkier and Simms 2010).

Figure 4-2: Flight directions of Geese *sp*. crossing Aberdeen Bay April 2010.

4.2.3 Summary of Results

Pink-footed geese were occasionally recorded in Aberdeen Bay during migration periods. Numbers recorded were generally low with no significant migration detected. The majority of birds were recorded flying above 30 m and most sightings were of birds within 2 km from shore.

Numbers of pink-footed geese recorded in Aberdeen Bay were below the threshold for a site of national importance.

4.2.4 Species Sensitivities

Qualifying species

The nearest SPAs to the proposed development for which the pink-footed goose is a qualifying species are the Ythan Estuary, Sands of Forvie and Meikle Loch SPA and Ramsar and the Loch of Strathbeg SPA and Ramsar. Elsewhere, the Montrose Basin, Firth of Forth and Firth of Tay and Eden Estuary SPA and Ramsar also have pink-footed geese as qualifying species (SNH 2011b).

Flight height

No pink-footed geese were recorded from boat-based surveys but flight heights from vantage point surveys indicated that between 50 – 100% of recorded flights were between 30 – 150 m above the sea surface and therefore at potential risk of collision.

Data from other offshore wind farms have recorded 46% of all flights as flying at potential rotor height (n=12,294).

Collision risk

Results from site specific surveys indicate that pink-footed geese occur in Aberdeen Bay particularly during the spring and autumn and are more frequently recorded within 2 km of the coast than further offshore (Figure 4-1).

The number of pink-footed geese recorded within the proposed development area was very low. However, concerns have been expressed over the potential for cumulative impacts arising with onshore wind farms in Aberdeenshire (RSPB 2011; SNH 2012). Consequently, collision risk modelling has been undertaken to determine the potential number of collisions arising from the proposed development both alone and in-combination with other plans or projects. Details of the collision risk modelling undertaken on pink-footed geese are presented in Appendix A3.

The results of the collision risk modelling indicate that up to four pink-footed geese per year may collide with the proposed EOWDC based on an avoidance rate of 99% as advised by SNH (SNH 2010a).

The annual mortality rate for pink-footed goose is 13.7% (BTO 2011). Consequently, out of a population of 340,000 an annual mortality of 45,560 pink-footed geese may be predicted. Therefore, 1% of the baseline mortality is 4,556 birds per year.

Based on the results from the collision risk modelling undertaken, the number of pink-footed geese that may collide is lower than the rate of baseline mortality, which may cause concern of a potentially significant impact on pink-footed geese.

To assess whether there is the potential for an adverse effect on pink-footed geese as a qualifying species for the relevant regional SPAs, the assessment is based on the 5 year peak mean counts as opposed to numbers published at the time of SPA citation as the populations of pink-footed geese have increased significantly since the SPA citations were originally made. It is also assumed that each SPA population is separate from each other and any collision impacts relate to birds only associated with that SPA. This is known to be an incorrect and precautionary assumption as ringing studies indicate that pink-footed geese frequently move between sites during the winter period and that many birds migrate south-west from North-east Scotland to north-west England and are therefore not going to interact with the proposed development (WWT 2007; Mitchell and Hearn 2004).

Five SPAs have been considered within this assessment (Table 4-2). The closest SPAs to the proposed EOWDC and therefore those at most risk of a potential adverse effect are the Ythan Estuary, Sands of Forvie and Meikle Loch SPA, the Loch of Strathbeg SPA and Montrose basin SPA. The results from the collision risk modelling indicate that for both sites the numbers of predicted collisions are below 1% of the baseline mortality rate. For sites further away, Firth of Forth and the Firth Tay & Eden Estuary SPAs the predicted number of collisions are similar to the 1% baseline mortality rates.

Table 4-2: Predicted natural mortality rates of pink-footed geese at relevant SPAs.

Site SPA/Ramsar	Population	Natural Mortality	1% of Natural Mortality
Ythan Estuary, Sands of Forvie and Meikle Loch	16,300	2,233	22
Loch of Strathbeg	53,454	7,323	73
Firth of Forth	3,220	441	4
Firth of Tay and Eden Estuary	2,704	370	4
Montrose Basin	38,911	5,330	53

Based on the above and the precautionary guidance threshold of a 1% increase in baseline mortality, the results from the collision risk modelling indicate that there is unlikely to be an adverse effect on the pink-footed goose populations at any of the SPAs from the proposed EOWDC.

The cumulative impacts arising from the proposed EOWDC and the currently operational wind turbines in Aberdeenshire indicate that 150 pink-footed geese per year may collide with onshore wind turbines (Appendix A3).

The number of pink-footed geese impacted may vary depending on the location and number of transits undertaken by each pink-footed goose across each of the onshore wind farm sites. This site specific information is not available. However, based on the results from collision risk modelling, the proposed EOWDC will account for 2.25% of the total collisions of pink-footed geese in the Aberdeenshire area.

Intensive surveys have been undertaken at offshore wind farms to assess the potential collision risk of pink-footed geese. All studies undertaken to date have indicated a very high avoidance rate for pink-footed geese and very low risk of collision.

Studies undertaken at Barrow offshore wind farm in the East Irish Sea reported that pink-footed geese recorded flying in line of the wind farm adjusted their flight height to pass above the wind farm and continue their migration. Of the nine pink-footed geese recorded entering the wind farm at rotor height, all flew between the turbines without any collisions. No collisions were observed from a total of 16,542 observed passing birds of all species during the 21 days survey at Walney Island (BOW 2007).

The results from three years of studies assessing the potential impacts on birds in the Kalmar Sound from the two offshore wind farms of Utgrunden and Yttre Stengrund recorded very few collisions of any species. Although only a small proportion of the birds observed were pink-footed geese, nearly 120,000 other geese were recorded flying through the Sound. These were mainly barnacle, brent and white-fronted geese. Both prior and post construction the majority of the Geese flew along the shores of the Sound, with relatively few through the wind farm area. However, the number of geese migrating through the wind farm area increased from 6% of the total prior to construction to 13% of the total post construction. A total of 7,224 geese were recorded in the autumns of 2001 and 2002, all of which were seen to avoid the turbines.

At Nysted offshore wind farm in Denmark intensive radar studies undertaken tracked amongst other species (notably eider), approximately 10,000 geese each autumn and the results indicate that there was a significant decrease in the proportion of flocks entering the wind farm from between the pre-construction period and the current operational period. It reported that post construction, 9% of the birds entered the turbines compared with 40% crossing the same location before construction and no geese were recorded colliding with the turbines (Deshom and Kahlert 2005).

Similar results obtained from Horns Rev have also indicated that Geese, including pink-footed geese, avoid operating offshore wind farms. A total of 11 flocks of geese observed on an intercept course with Horns Rev, one flock of 53 individuals was observed entering the wind farm area, without changing course, the remaining 10 flying past also without apparently altering course. Although course changes could have occurred before entering the radar area or due to their original line of approach they had no need to consider altering course. The flock that did alter course increased flight altitude when approaching the wind farm and when flying within the wind farm, ultimately flying at rotor height. Within the wind farm, the birds appeared to show less stability in flight resulting in a disrupted flock structure. The mean altitude of geese flocks was 64.2m and all flocks were within the rotor height (Christensen *et al.* 2004).

A total of 560 hours of observations undertaken at the eight turbines that make up the Rønland offshore wind farm in Denmark used both visual observations and radar to detect birds at night. Out of 30,977 birds recorded, 7,309 were Brent geese.

Two collisions: one of a cormorant and the other of a pale bellied Brent goose were recorded during the study. This accounts for 0.07% of the total observations. Observations indicate that approximately 8% of all birds flew within 100 metres of the turbines and 4.5% of the flocks. The risks of collision were much lower than those reported at other Danish wind farms (Jensen 2006).

Table 4-3 presents a summary of the data obtained on geese from existing constructed wind farms and the actual number of observed collisions. It is recognised that the total number of geese recorded includes geese observed that may not have had to take any avoidance behaviour as they were not originally flying in line with the turbines and also that the observed collisions only occur during periods of daylight.

Table 4-3: Summary of data obtained on geese from constructed offshore wind farms.

Wind farm	No. of turbines	Length of study post construction	Species recorded	Total no. recorded	No. of observed collisions
Utgrunden and Yttre Stergrund [1]	12	2 years	Bean goose	284	0
			Pink-footed goose	3	0
			White-fronted goose	9,992	0
			Greylag goose	1,143	0
			Canada Goose	311	0
			Barnacle goose	68,787	0
			Brent goose	17,592	0
			Red-breasted goose	1	0
			Goose *Sp.*	5,293	0
Nysted [2]	72	3 years	Barnacle Goose	2,353	0
			Brent Goose	3,450	0
Horns Rev [2]	80	3 years	Greylag goose	123	0
			Brent goose	142	0
			Goose *Sp.*	10	0
Rønland [3]	8	3 years	Brent goose	7,309	1
Barrow [4]	30	1 year	Pink-footed goose	4,732	0
Totals	*202*	*12 years*	*8 Species*	*121,525*	*1*

References: [1] Pettersson 2005, [2] Petersen *et al*. 2006, [3] Jensen 2006, [4] BOW 2007

Based on the above and the results of the collision risk modelling undertaken and the site specific data indicating a low usage of the site by pink-footed geese it is concluded that potential impacts will be temporally long-term of negligible magnitude and may be of minor significance.

Barrier effect

Although pink-footed geese may fly through wind farms (e.g. BOW 2007) they have also been recorded avoiding wind farms; consequently there may be a barrier effect

Should a barrier effect occur then pink-footed geese will fly around the proposed development. By doing so, this could cause an overall increase in flying distance of up to approximately 3.2 km. For a bird migrating from Iceland to North-east Scotland, a distance of over 1,000 km then this will cause an increase of 0.3% in flight distance. This is considered to be a temporally long-term, negligible magnitude and significance.

Displacement

Pink-footed geese do not use Aberdeen Bay for feeding or roosting and therefore no displacement effects will occur. Any impacts, should they occur, will be of negligible magnitude and significance.

Cumulative and in-combination

The cumulative impacts arising from the proposed EOWDC and the currently operational wind turbines in Aberdeenshire indicate that 150 pink-footed geese per year may collide with onshore wind turbines.

Potential cumulative and in-combination impacts on pink-footed geese have been addressed by many Round 1 and Round 2 offshore wind farms.

Collision risk modelling undertaken for the proposed Beatrice Offshore Wind Farm, located in the Moray Firth, indicates that up to 36 pink-footed geese per year may collide with the wind farm (BOWL 2012).

Cumulative collision risk totals based on collision risk modelling are presented in Table 4-4. The collision risk modelling undertaken at the time considered avoidance rates of 95%, 99% and 99.5%. Based on an avoidance rate of 99% a total of up to 203 pink-footed geese are predicted to be impacted from all the currently consented offshore wind farms. Based on the total UK population of 340,000 and 1% baseline mortality rate of 4,556 individuals per year the cumulative impacts from existing offshore wind farms are therefore considered to be temporally long-term of negligible magnitude and not significant.

The proposed EOWDC may result in an additional four pink-footed gees collisions per year.

Table 4-4: Predicted potential collision mortality for pink-footed geese from offshore wind farms.

Site	Avoidance rate		
	95%	**99%**	**99.5%**
Ormonde	77	15	8
Walney	6	1	<1
West of Duddon Sands	5	1	<1
Barrow	15	15	8
Docking Shoal		15	8
Humber Gateway		48	24
Lincs	171 – 262	34 – 52	17 – 26
Lynn and Inner Dowsing	100 – 165	20 – 33	10 – 17
Beatrice		36	
Total	*374 - 530*	*185 – 203*	*69 – 85*
EOWDC	**-**	**4**	**-**

Note: the avoidance rate used in the Beatrice collision risk modelling is unknown but presumed to be 99%.

Population Viability Analysis (PVA) undertaken on pink-footed geese indicates that the pink-footed goose population may be able to withstand an increase in mortality (from whichever source) of 5,000 birds per year (Trinder *et al.* 2005). Further PVA commissioned by DECC to model the possible effects of additional mortality on the pink-footed goose population over a 25 year period indicated that over a 25 year period there was a 2% chance of the pink-footed goose population decreasing to below 150,000 if, due to collisions, wind farms increase the annual mortality by more than 1,000 birds over and above current impacts, e.g. hunting (Trinder 2008). The predicted level of mortality from all offshore wind farms based on precautionary collision risk modelling indicates that the level of mortality is below the threshold above which cumulative mortality rates could have an adverse long-term effect. The potential magnitude will be negligible and the impact of minor significance.

Table 4-5: Summary of significance of potential impacts on pink-footed goose.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	High	Negligible	Medium	Negligible
Operation	Collision	Very High	Negligible	Long-term	Minor
	Displacement	High	Negligible	Long-term	Negligible
	Barrier	High	Negligible	Long-term	Negligible
Decommissioning	Displacement	High	Negligible	Medium	Negligible
Cumulative	All	Very High	Negligible	Long-term	Minor

4.2.5 Conclusions

Habitats Appraisal

Based on the site specific data indicating a low usage of the area by pink-footed geese and evidence from existing offshore wind farms indicating a very high avoidance rate; an adverse effect will not occur at any of the SPAs for which pink-footed goose is a qualifying species.

Environmental Impact Assessment

Based on the site specific data and data from existing offshore wind farms it is predicted that there will not be a significant environmental effect arising from the proposed development on pink-footed geese.

4.3 Greylag goose (*Anser anser*)

4.3.1 Protection and Conservation Status

The Greylag goose is listed in Appendix II of the Bern Convention, Appendix II of the Bonn Convention and is on the Amber List of Species of Conservation Concern.

4.3.2 Background

Greylag goose (Icelandic population)		
GB Population	Winter: 108,507 ind.	Holt *et al.* 2011
Scottish Population	Summer: 25,000 prs. Winter – 85,000 ind.	Forrester *et al.* 2007
International threshold	870 ind.	Calbrade *et al.* 2010
GB threshold	850 ind.	Holt *et al.* 2011
Designated east coast sites where species is a noted feature	Loch of Skene: 760 (2010) Loch of Strathbeg: 580 (2007) Montrose Basin: 2,519 (2011) Firth of Tay: 1,943 (09/10)	SNH 2011b JNCC 2011a Holt *et al.* 2011
European population estimate	Breeding: 120,000 – 190,000 prs. Wintering: >390,000 ind.	Birdlife 2004
European population trend	Status 'secure' Trend 'large increase'	Birdlife 2004
World population	1 – 1.100,000 'adults'	Birdlife 2011

Greylag geese breed in Iceland, north-west Scotland and many parts of Eurasia. They winter along the north-west and east coasts of Scotland particularly in Orkney where the population of over wintering birds has increased substantially in recent years from 3,000 in the 1990s to 43,000 in 2003 (Forrester *et al.* 2007). During the winter birds forage on farmland and are relatively sedentary until March when they start returning to their breeding grounds (Forrester *et al.* 2007).

In North-east Scotland greylag geese have been recorded passing Peterhead, primarily in October with relatively few at other times of the year. In October up to 180 birds per month were recorded between 1978 and 1988 (Innes 1996). The wintering population of greylag geese in North-east Scotland has decreased in recent years as birds that used to winter in the region are now thought to do so in Orkney. Only relatively small numbers now winter at what used to be large winter roosts, particularly the Loch of Skene and Dinnet lochs that held up 15,000 and 30,000 birds each in the 1990's and now hold less than 1,000 birds each (Buckland, Bell and Picozzi 1990; NESBR).

The Greylag goose is a notified feature for Corby Loch SSSI, which lies 4 km north of Aberdeen. Up until the early 1990s there was a winter roost of greylag geese of up to 2,600 birds on Corby Loch but since then the numbers roosting there have declined and the loch is now only infrequently used by greylag geese (Hearn and Mitchell 2004, NESBR).

Boat-based surveys

No greylag geese were recorded during any of the boat-based surveys undertaken between February 2007 and April 2008 and between August 2010 and August 2011 (SMRU 2011b, SMRU 2011c).

Vantage Point surveys

In Aberdeen Bay, greylag geese were recorded from vantage point sites during December 2006 and January 2007. Four small skeins were recorded totalling 37 birds flying between 1 - 3 km from shore and none were within the 30 - 150 m height band (EnviroCenter 2007b). Further singles were recorded once in August 2006 and March 2008.

Bird Detection Radar

No positive sightings of greylag geese were made from the radar studies undertaken in October 2005, April 2007 or April 2010 (Walls *et al*. 2006; Simms *et al* 2007; Plonckzkeir and Simms 2010).

4.3.3 Summary of Results

Greylag geese were only occasionally recorded in Aberdeen Bay with the only records of note during December 2006 and January 2007. The few sightings were of birds below 30 m and within 3 km from shore.

Numbers of greylag geese recorded in Aberdeen Bay were below the threshold for a site of national importance.

4.3.4 Species Sensitivities

Qualifying species

The nearest SPAs to the proposed development for which the greylag goose is a qualifying species are the Loch of Skene SPA and the Loch of Strathbeg SPA and Ramsar. The greylag goose is also a qualifying species for Montrose Basin SPA and Ramsar and Firth of Tay SPA and Ramsar (SNH 2011b).

Flight height

No greylag geese were recorded from boat-based surveys but flight heights from vantage point surveys indicated that none were flying between 30 m - 150 m and therefore not at potential risk of collision.

There is very limited data on flight heights of greylag geese from other offshore wind farms (Table 4-3). However, data from birds moving to and from roosts in North-east Scotland recorded 33% of flights as being between 50 m - 150 m (Patterson 2006).

Collision risk

Data from site specific surveys indicate that greylag geese occasionally occur in Aberdeen Bay, particularly during the winter. However, as there were only six records of a total of 39 birds from all surveys and all were flying below turbine height the frequency of occurrence is low. Monitoring results from other offshore wind farms for all geese species indicate that they have a very high avoidance rate (Table 4-3) and even if the area is used more extensively than records suggest, this and low flight altitude indicate that the risk of collision is low and the impact on greylag geese should it occur, is of negligible magnitude, long-term and of potential minor significance.

Barrier effect

Although greylag geese may fly through wind farms they have also been recorded avoiding wind farms; consequently, there may be a barrier effect.

Should a barrier effect occur, then greylag geese will fly around the proposed development. By doing so this could cause an overall increase in flying distance of up to approximately 3.2 km. For a bird migrating from Iceland to North-east Scotland, a distance of approximately 1,000 km, then this will cause an increase of

0.3% in flight distance. This is considered to be of negligible magnitude long-term impact and of negligible significance.

Displacement

Greylag geese do not feed offshore nor roost on the sea (Snow and Perrins 1998). Greylag geese do not use Aberdeen Bay for feeding or roosting (NESBR) and therefore no displacement effects will occur. Any impacts will be of negligible magnitude and significance.

Cumulative and in-combination

No cumulative or in-combination impacts on greylag geese have been recorded for any of the existing Round 1 or Round 2 offshore wind farms. Collision risk modelling undertaken for the proposed Beatrice offshore wind farm predicts up to four greylag geese per year may collide with the turbines. There are no other data available yet on whether greylag geese are being recorded during surveys being undertaken for other planned Round 3 offshore wind farms or those in Scottish Territorial Waters. However, the majority of greylag geese wintering in the UK are now doing so in Orkney and Caithness (Holt *et al*. 2011) and are therefore not at risk of potential cumulative or in-combination impacts with other offshore wind farms to the south.

On the basis that there is unlikely to be any substantial interaction with other offshore wind farms and that, as with other Geese, it is predicted that there will be a high avoidance rate, small potential of a barrier effect and no displacement, it is concluded that there will be a negligible long-term adverse effect or cumulative impact.

Table 4-6: Summary of the significance of potential impacts on greylag goose.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	High	Negligible	Medium	Negligible
Operation	Collision	Very High	Negligible	Long-term	Minor
	Displacement	High	Negligible	Long-term	Negligible
	Barrier	High	Negligible	Long-term	Negligible
Decommissioning	Displacement	High	Negligible	Medium	Negligible
Cumulative	All	Very High	Negligible	Long-term	Minor

4.3.5 Conclusions

Habitats Appraisal

Based on the site specific data indicating a low usage of the area by greylag geese and evidence from existing offshore wind farms indicating a very high avoidance rate for Geese as a whole an adverse effect is not predicted to occur at any of the SPAs for which greylag goose is a qualifying species.

Environmental Impact Assessment

Based on the site specific data and data from existing offshore wind farms it is predicted that there will not be a significant environmental effect arising from the proposed development on greylag geese.

4.4 Barnacle goose (*Branta leucopsis*)

4.4.1 Protection and Conservation Status

The barnacle goose is listed in Annex I of the Birds Directive, Appendix II of the Bern Convention, Appendix II of the Bonn Convention and is on the Amber List of Species of Conservation Concern.

4.4.2 Background

Barnacle goose (Svalbard population)		
GB Population	Winter – 32,800 ind.	Holt *et al.* 2011
Scottish Population	Winter – 32,800 ind.	Holt *et al*. 2010
International threshold (Svalbard)	270 ind.	Calbrade *et al.* 2010
GB threshold	330 ind.	Holt *et al.* 2010
Designated east coast sites where species is a noted feature	Loch of Strathbeg.	JNCC
European population estimate	Breeding 41 – 54,000 pairs. Wintering – 370,000.	Birdlife 2004
European population trend	Status 'secure' Trend 'large increase'	Birdlife 2004
World population (Svalbard)	32,800 ind.	Calbrade *et al.* 2010

Barnacle geese breed in the Arctic and winter in the UK and the mainland of Europe. They arrive in their UK wintering grounds during September and October and migrate north again during the spring. There are two distinct populations wintering in the UK. Birds from Svalbard occur in North-east Scotland as mainly passage migrants on their way to and from their main wintering site on the Solway Firth. Barnacle geese from Greenland winter along the west coast of Scotland and are not known to occur in the region.

The population of barnacle geese wintering in the Solway has increased considerably since the 1940s when there were 300 individuals. The wintering population has now increased to around 32,800 individuals (Holt *et al*. 2011; Forrester *et al.* 2007).

Barnacle geese have been recorded passing Peterhead from late September through to late October when up to 400 birds per month have been recorded and again in the spring when up to 250 birds per month were recorded flying north during April and May. Birds were recorded out to a distance of 3 km (Innes 2006).

Peak counts at Loch of Strathbeg and elsewhere in North-east Scotland vary considerably across years but numbers have increased with up to 680 in October 2006 and 600 in May 2008 (NESBR) and an exceptional 6,000 in September 2005. During the same period up to 2,270 were recorded flying south at Blackdog (Buckland, Bell and Picozzi 1990; NESBR 2006). The Loch of Strathbeg is an important staging post for barnacle geese from Svalbard and is one of only three sites in the UK that holds internationally important numbers; the others being the Solway Firth and Lindisfarne (Calbrade *et al.* 2010; Holt *et al*. 2011).

Boat-based surveys

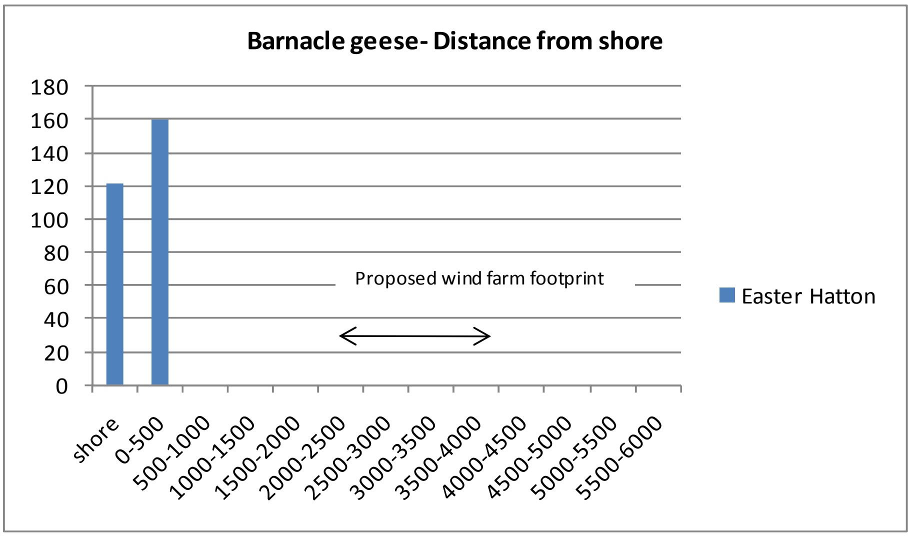
A total of 831 barnacle geese were recorded from boat-based surveys undertaken between February 2007 and January 2008 and August 2010 and August 2011. All sightings were made on the 12 October 2007 when 14 skeins of barnacle geese were recorded ranging in size from 7 to 220 birds, the majority of which were recorded along a single transect indicating a single 'pulse' of migrating barnacle geese occurred during that survey period (Appendix B). The majority of birds were flying in a southerly direction and 29% were flying above 200 metres; 32% were between 15 m and 200 m and 6% between 25 m and 200 m.

Vantage Point surveys

Up to 300 barnacle geese per hour were recorded past Drums in September 2006 and single skeins of 29 in December 2007 and 17 in January 2008 (Alba Ecology 2008b). Of the 300 birds recorded in 2006, nine birds per hour were recorded flying between 30 m and 150 m above sea surface. The majority of records were from between 1 - 2 km from shore with no sightings further offshore.

Bird Detection Radar

A total of five flocks of barnacle geese, comprising 281 birds, were recorded during the studies undertaken in October 2005. All sightings were of birds flying below 35 m and were within 500 m from shore (Figure 4-3) (Walls *et al.* 2006).



(Adapted from Walls *et al.* 2006, Simms *et al.* 2007)

Figure 4-3: Number of barnacle geese recorded and distance from shore at Easter Hatton during October 2005.

4.4.3 Summary of Results

Barnacle geese were the most frequently recorded goose in Aberdeen Bay where large numbers were recorded passing through the bay during September 2006 and on one date in October 2007. Relatively few barnacle geese were recorded outwith these peak periods. No geese were reported as having landed in the bay. Land based observations recorded the majority of birds within 2 km from shore but there were sightings out to at least 3 km. Of those birds recorded in flight from boat-based surveys, 6 were flying above 25 m but below 200 m. Land-based observations recorded all barnacle geese as flying below 35 m.

The number of barnacle geese passing through Aberdeen Bay was above the threshold for a site of national and international importance.

4.4.4 Species Sensitivities

Qualifying species

The nearest SPAs to the proposed development for which the Svalbard population of the Barnacle goose is a qualifying species are the Loch of Strathbeg and Solway Firth SPAs (JNCC 2011a, SNH 2011b).

Flight height

Data from site specific boat-based studies recorded up to 7.7% of the barnacle geese as flying between 25 m and 200 m and therefore at turbine height.

There are currently no other data available on flight heights of barnacle geese from other UK offshore wind farms.

Collision risk

Results from site specific surveys indicate that barnacle geese occur in Aberdeen Bay particularly during the spring and autumn and are more frequently recorded within 2 km of the coast than further offshore.

Collision risk modelling undertaken for barnacle goose is based on:

- Body length of 64 cm
- Wingspan of 139 cm
- Flight speed of 18.0 $m.s^{-1}$
- Percentage at rotor height –100%
- Avoidance rate – 98, 99, 99.5%

(Patterson 2006).

As the number of barnacle geese recorded within the proposed development area was low, in order to undertake collision risk modelling based a potentially realistic 'worst-case' scenario the following assumptions were made:

1. The total number of barnacle geese passing through North-east Scotland each autumn is 2,200, based on the peak count at Loch of Strathbeg since 2004 (Calbrade *et al.* 2010).
2. All barnacle geese migrate south across a front of up to 5 km offshore and 5 km inland and therefore over a 10 km wide front. The maximum width of the proposed development is 2.75 km and therefore intercepts 27.5% of the potential flight path. This is a precautionary figure as site specific data indicates that the majority of geese fly within 1 km from shore and therefore do not interact with potential development. However, for the purposes of the collision risk modelling it assumed that 27.5% of the total Svalbard breeding population of barnacle geese pass through the offshore area, i.e. 6,336 birds per year.
3. That a return passage during the spring occurs at the same level as in the autumn.

The collision risk modelling has been undertaken on the original Rochdale envelope and the revised Rochdale envelope (Table 3-5) and based on a 99% avoidance rate.

Table 4-7: Results from collision risk modelling undertaken on barnacle geese.

	Avoidance rate (%)	
	0%	**99%**
Original Rochdale	827	8.2
Revised Rochdale	714	7.1

Based on the various scenarios and using a precautionary avoidance rate of 99% as recommended by SNH (SNH 2010a), it is predicted that a total of 7 collisions per year may occur (Table 4-7).

The annual mortality rate for barnacle goose is 9% (BTO 2011). Consequently, out of a population of 32,000 an annual mortality of 2,880 barnacle geese may be predicted. Therefore, 1% of the baseline mortality is 28 birds per year.

Based on the results from the precautionary collision risk modelling undertaken, the number of barnacle geese that may collide is lower than that that may cause concern or a potentially significant impact or adverse effect on the barnacle goose population as a whole.

To assess whether there is the potential for an adverse effect on barnacle goose as a qualifying species for the relevant regional SPAs, the assessment is based on the 5 year peak mean counts as opposed to numbers published at the time of SPA citation this is because the populations of barnacle geese have increased significantly since the SPA citations were originally made. It also, incorrectly, assumes that each SPA population is separate from each other and any collision impacts relate to birds only associated with that SPA. It is known that barnacle geese recorded at Loch of Strathbeg are the same individuals as those occurring at the Solway Firth (Griffin, Rees and Hughes 2011).

Table 4-8: Natural mortality rates for barnacle geese associated with relevant SPAs.

Site SPA	Population (ind.)	Natural Mortality	1% of Natural Mortality
Loch of Strathbeg	726	65	0.6
Solway Firth	29,403	2,646	26

Based on the above, the results from the collision risk modelling indicate that there is the potential for an adverse effect to occur should all potential collisions relate to geese associated with only the Loch of Strathbeg SPA.

Collision Risk Modelling undertaken by SNH assesses the potential cumulative impact from four proposed offshore wind farms in the Firth of Forth: Neart na Gaoithe, Inch Cape, Forth Array[1] and Firth of Forth (SNH *unpublished*). The results of the modelling estimated a total of 37 barnacle geese collisions per year across all four wind farms.

[1] Note the Forth array is no longer a proposed offshore wind farm but was included within the collision risk modelling at the time of it being undertaken.

As described in section 4.2.4 there are numerous studies indicating that Geese are at low risk of collision. Nearly 87,000 barnacle geese were recorded migrating past two offshore wind farms in Kalmar Sound where avoidance behaviour was observed and no collisions detected (Pettersson 2005). Similar results from other offshore wind farms for other similar species of geese support the findings of the study (Table 4-3).

Based on the above data and the highly precautionary nature of the collision risk modelling undertaken as well as the site specific data indicating a relatively low usage of the site by barnacle geese, it is concluded that the potential magnitude of any impacts will be negligible and duration long-term and of minor significance.

Barrier effect

Although barnacle geese may fly through wind farms they have also been recorded avoiding wind farms, consequently there may be a barrier effect (Pettersson 2005).

Should a barrier effect occur then barnacle geese will fly around the proposed development. By doing so this could cause an overall increase in flying distance of up to approximately 3.2 km. For a bird migrating from Svalbard to North-east Scotland, a distance of approximately 2,500 km, then this will cause an increase of 0.1% in flight distance. This is considered to be of negligible magnitude and significance.

Displacement

Barnacle geese do not feed or roost on nearshore waters (Snow and Perrins 1998) and do not use Aberdeen Bay for roosting or feeding (NESBR); therefore no displacement effects will occur. Any impacts will be of negligible magnitude and significance.

Cumulative and in-combination

Barnacle geese migrating from Svalbard to the Solway Firth do so by travelling down the west coast of Norway before crossing to north-east and eastern Scotland and flying south-west to the Solway where they winter. Their return flights are similar but more direct and to the south of the proposed development area (Griffin, Rees and Hughes 2011). Consequently, there are little cumulative or in-combination impacts from existing offshore wind farms. There is the potential for cumulative impacts arising with planned developments in the Firth of Forth and Moray Firth areas. Cumulative collision risk modelling undertaken by SNH indicates up to 37 barnacle geese per year are at risk of collision with the proposed Firth of Forth developments and less than one per year is predicted to collide with the Beatrice offshore wind farm (BOWL 2012). The relatively low numbers predicted to be impacted indicate that the potential magnitude of any impact will be negligible and of minor significance.

Table 4-9: Summary of the significance of potential impacts on barnacle goose.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	High	Negligible	Medium	Negligible
Operation	Collision	Very High	Negligible	Long-term	Minor
	Displacement	High	Negligible	Long-term	Negligible
	Barrier	High	Negligible	Long-term	Negligible
Decommissioning	Displacement	High	Negligible	Medium	Negligible
Cumulative	All	Very High	Negligible	Long-term	Minor

4.4.5 Conclusions

Habitats Appraisal

Based on the site specific data indicating a low usage of the area by barnacle geese and evidence from existing offshore wind farms indicating a very high avoidance rate; an adverse effect will not occur at any of the SPAs for which barnacle goose is a qualifying species.

Environmental Impact Assessment

Based on the site specific data and data from existing offshore wind farms it is predicted that there will not be a significant environmental effect arising from the proposed development on barnacle geese.

4.5 Shelduck (*Tadorna tadorna*)

4.5.1 Protection and Conservation Status

The Shelduck is listed in Appendix II of the Bern Convention, Appendix II of the Bonn Convention and is on the Amber List of Species of Conservation Concern.

4.5.2 Background

Shelduck		
GB Population	Summer: 11,000 prs. Winter: 78,000 ind.	BTO 2011
Scottish Population	Summer: 1,750 prs. Winter: 7,000 ind.	Forrester *et al.* 2007
International threshold	3,000 ind.	Holt *et al.* 2011
GB threshold	610 ind.	Holt *et al.* 2011
Designated east coast sites where species is a noted feature	Montrose Basin: 1,191 (09/10) Firth of Forth: 4,047 (09/10) Firth of Tay and Eden Estuary: 1,114 ind.	Calbrade *et al.* 2010 JNCC 2011a Holt *et al.* 2011
European population estimate	Breeding: 41 – 54,000 prs. Wintering: 370,000 ind.	Birdlife 2004
European population trend	Status 'secure' Trend 'small decline'	Birdlife 2004
World population	580,000 – 710,000 'adults'	Birdlife 2011

Shelduck is a widespread coastal breeding species in the UK with a UK breeding population of 11,000 pairs, of which 1,750 pairs breed in Scotland (Forrester *et al*. 2007). In winter they occur along coastal estuaries and mud flats. A proportion of Scottish breeding shelduck undertake a seasonal migration to Helgoland during July where they moult and return to eastern England in late August after which they then move north to their wintering grounds. There is also a moulting flock in the Firth of Forth.

In Eastern Scotland shelduck occur widely in suitable coastal habitats with the main sites being the Firth of Forth and Montrose Basin where mean peak counts of up to 3,166 and 988 individuals have been recorded between 2004 and 2009 (Calbrade *et al*. 2010).

Sightings of shelduck past Peterhead occurred throughout the year but with a distinct spring passage when up to 300 birds per month pass, predominantly northwards. The majority of sightings were within a few hundred metres from shore (Innes 1996).

In North-east Scotland Shelduck occur throughout the year but most of the population leaves on moult migration during July with birds returning from December and March (Patterson 2011). During the breeding season shelduck occur widely along all suitable sandy and muddy coasts, in particular, the Ythan Estuary where up to 200 birds may occur in the spring and between 50 and 80 pairs breed on the adjacent Forvie nature reserve out of an estimated North-East Scotland population of 125 pairs (Patterson 2011; Buckland, Bell and Picozzi 1990).

Boat-based surveys

Seven shelduck were recorded during boat-based surveys with two in April, four in May and one in January. The January bird was heading north while the spring birds were flying in a southerly direction. All records were of birds flying below 25 m.

Vantage Point surveys

Shelduck were recorded infrequently during vantage point surveys with a total of 37 individuals over the two years of surveys (April 2006 to March 2008). Most records were between March and May, although the maximum count was in August when ten were seen in 2006. There were two records during winter months with one in January 2008 and three in February 2007.

Bird Detection Radar

Five shelduck were recorded, with one at Drums and four at Easter Hatton in five days of surveys during October 2005 (Walls *et al*. 2006). A further 20 birds were seen during additional radar studies undertaken at Blackdog in April 2007 (Simms *et al.* 2007).

4.5.3 Summary of Results

Shelduck were regularly recorded in low numbers from shore-based counts, particularly during the spring period. Of those for which flight heights were reported all shelduck were flying below 25 m.

The number of shelduck recorded in Aberdeen Bay was below the threshold for a site of national importance.

4.5.4 Species Sensitivities

Qualifying species

There are three SPAs in the region for which shelduck are part of the qualifying assemblage: Montrose Basin, Firth of Forth and Forth and Tay Estuary SPA.

Flight height

Of those recorded in flight and for which flight heights were recorded all were flying below 25 m (Table 3-6).

Elsewhere data from other offshore wind farms on flight heights for shelduck are limited, with only eleven recorded flight heights from surveys undertaken at ten offshore wind farms. The few records recorded 36% of flights at rotor height.

Collision risk

Site specific monitoring indicates that shelduck are scarce in Aberdeen Bay and those for which flight heights were recorded were below turbine height and most records were of birds within 2 km of the coast. Consequently, the risk of significant environmental impact arising from collision is low and should it occur the significance on the regional population is negligible. The SPAs for which shelduck are qualifying species as part of assemblages are over 60 km away and the likelihood of shelduck associated with these SPAs being at risk of collision from the proposed development is remote. The collision impacts on the qualifying species caused by collision mortalities arising from the proposed development are temporally long-term but of negligible magnitude and minor significance.

Barrier effect

There are no data on the behaviour of shelduck at offshore wind farms but based on behaviour reported for other wildfowl (e.g. Petersen *et al.* 2006, Pettersson 2005) it is predicted that at least some shelduck will avoid flying through the proposed development.

Should a barrier effect occur then shelduck may fly around the proposed development. This would incur an overall increase in flying distance of approximately 3.2 km. The movements of shelduck in Aberdeen Bay are not fully understood but site specific boat-based and land-based surveys did not record any regular feeding or roosting flights across the bay; nor have there been any reported in local ornithological records (NESBR). Consequently, many flights are potentially *ad hoc* and or passage related; therefore, any additional energetic costs arising from the proposed development will not be regular occurrence but likely to be only occasional. The relatively small additional distance flown should shelduck fly around the proposed development on an occasional basis will not be significant nor have an adverse effect.

Displacement

Shelduck do not feed or forage offshore (Snow and Perrin 1998) nor have they been reported using Aberdeen Bay for feeding or roosting (NESBR). Therefore no displacement effects will occur.

Cumulative and in-combination

The low level of usage of the site by shelduck indicates that there will not be any cumulative or in-combination impacts with other plans or projects.

Table 4-10: Summary of the significance of potential impacts on shelduck.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Medium	Negligible	Medium	Negligible
Operation	Collision	Very High	Negligible	Long-term	Minor
	Displacement	Medium	Negligible	Long-term	Negligible
	Barrier	High	Negligible	Long-term	Negligible
Decommissioning	Displacement	Medium	Negligible	Medium	Negligible
Cumulative	All	Very High	Negligible	Long-term	Minor

4.5.5 Conclusions

Habitats Appraisal

Based on the distance at which SPAs occur for which shelduck is a qualifying species, the low numbers recorded within the proposed development area and known behaviour of shelduck there will be no adverse effect on the SPAs for which shelduck is a qualifying species.

Environmental Impact Assessment

Based on the relatively low numbers of shelduck recorded and their known behaviour it is predicted that there will not be a significant environmental effect arising from the proposed development on shelduck.

4.6 Eurasian Wigeon (*Anas Penelope*)

4.6.1 Protection and Conservation Status

The (Eurasian) wigeon is listed in Appendix II of the Bonn Convention, Appendix III of the Berne Convention and is on the Amber List of Species of Conservation Concern.

4.6.2 Background

Wigeon		
GB Population	Winter: 372,331 ind.	Holt *et al*. 2010
Scottish Population	Summer: 240 – 400 prs. Winter: 76,000 – 96,000 ind.	Forrester *et al.* 2007
International threshold	15,000 ind.	Calbrade *et al*. 2010
GB threshold	4,400 ind.	Holt *et al*. 2010
Designated east coast sites where species is a noted feature	Montrose Basin: 3,944 ind. Firth of Forth: 2,139 ind.	Calbrade *et al.* 2010 JNCC 2011a
European population estimate	Breeding: 85,000 – 100,000 prs. Wintering: >140,000 ind.	Birdlife 2004
European population trend	Status 'decreasing' Trend 'moderate decline	Birdlife 2004
World population	2,800,000 to 3,300,000	Birdlife 2011

Wigeon occur widely across northern Europe and Russia and there is a relatively small breeding population in the UK with between 48 and 124 pairs of which between 25 to 50 pairs breed in North-East Scotland (Holling *et al*. 2010; Duncan 2011a). In the autumn wigeon arrive from central and eastern Europe and Russia to winter in the UK where there is a large wintering population of 360,000 individuals of which between 76,000 and 96,000 winter in Scotland (Wernham *et al*. 2002, Forrester *et al*. 2007).

During the non-breeding season wigeon are mainly coastal, foraging on mudflats and coastal foreshores.

The main wintering sites in Scotland are the Moray Firth where up to 20,000 wigeon may winter and the Dornoch Firth with up to 15,000 wintering wigeon. In North-east Scotland wigeon occur widely with an average peak count in the region between 1992 and 2002 of 3,045 (Forrester *et al*. 2007). On the Ythan Estuary peak counts of wigeon occur during the winter months when up to 1,000 birds may be present, particularly during November and December (NESBR). Peak numbers of wigeon passing Peterhead occurred during September and October with few sightings during the winter. There is evidence of a small spring passage of birds heading north during March, April and May (Innes 1996). All sightings at Peterhead were of birds passing within a few hundred metres from shore.

Boat-based surveys

Thirty wigeon were recorded during boat-based surveys with a flock of 20 birds in September 2007 and nine birds in three flocks in October 2007. The only other record was of a single bird in April 2008.

Vantage Point surveys

Wigeon were observed flying through Aberdeen Bay between April 2007 and March 2008 with up to seven birds per hour passing Blackdog during October 2007. The majority of sightings from the Donmouth were between 2 and 3 km from the shore, whereas those from Blackdog were predominantly 1 and 2 km from shore. All records were of birds flying below 30 metres (Alba Ecology 2008a,b).

Further records all of less than 20 birds were from Blackdog in August, September and December, Balmedie in September and Drums in December (EnviroCentre 2007).

Bird Detection Radar

Sixteen wigeon were recorded, at Easter Hatton during the studies undertaken in October 2005 and 10 were seen from Blackdog during further radar studies undertaken in April 2007 (Walls *et al*. 2006, Simms *et al.* 2007).

4.6.3 Summary of Results

Relatively few wigeon were recorded during surveys undertaken in Aberdeen Bay. Most records were obtained from vantage point surveys with birds recorded out to 3 km from shore. Of those for which flight height was reported, the majority were flying between 25 m and 100 m.

4.6.4 Species Sensitivities

Qualifying species

There are two SPAs in the region for which wigeon are part of the qualifying assemblage: Montrose Basin and Firth of Forth SPA and Ramsar.

Flight height

Observations made from site specific boat-based surveys recorded all but one wigeon as flying below between 25 and 100 m in flight.

Elsewhere data from other offshore wind farms on flight heights for wigeon are limited with only 60 recorded flight heights from surveys undertaken at ten offshore wind farms. The few records recorded 38% of flights at rotor height.

Collision risk

Site specific monitoring indicates that wigeon are regular in Aberdeen Bay but in relatively low numbers. At Nysted offshore wind farm 1% of all records were of wigeon. Passage rates of up to 20 birds per hour were detected and no collisions were recorded (Petersen *et al*. 2006). At Kalmar Sound 25,000 wigeon were counted during migration and no collisions observed (Pettersson 2005). Based on the relatively low numbers of wigeon recorded and evidence from offshore wind farms, where wigeon are relatively common, it is concluded that the impacts will be temporally long-term but of negligible magnitude and significance.

Barrier effect

Studies undertaken at Kalmar Sound suggest that there is the potential for some barrier effects as wigeon may avoid flying through offshore wind farms (Pettersson 2005). Should a barrier effect occur then wigeon will fly around the proposed development. This may incur an overall increase in flying distance of approximately 3.2 km. Based on site specific surveys and records published in North-East Scotland Bird reports (NESBR) there are no regular feeding or roosting flights by wigeon across Aberdeen Bay and the seasonal occurrence of wigeon recorded suggest that the majority of birds are on migration. Migrating wigeon could be moving to or from breeding grounds in Iceland, Scandinavia, Russia or from the small UK breeding population. They may be wintering in the UK or elsewhere in Europe (Wernham *et al* 2002). However, the majority of recoveries from wigeon ringed in northern Scotland indicate that the majority of wigeon in the region originate from Iceland (Owen and Mitchell 1988).

Barrier effects will be temporally long-term but the relatively small additional distance of 3.2 km that may be flown should there be a barrier effect compared to the total distance of their migration, likely to be to Iceland, will not be significant nor have an adverse effect.

Displacement

Wigeon do not feed or roost in offshore waters (Snow and Perrins 1998). Based on results from site specific surveys and reports within North East Scotland Bird Reports wigeon do not use Aberdeen Bay for feeding or roosting and therefore no displacement effects will occur (NESBR).

Cumulative and in-combination

The low level of usage of the site by wigeon and the relatively few recorded from other UK developments indicate that there will not be any cumulative or in-combination impacts.

Table 4-11: Summary of the significance of potential impacts on wigeon.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Medium	Negligible	Medium	Negligible
Operation	Collision	Medium	Negligible	Long-term	Negligible
	Displacement	Medium	Negligible	Long-term	Negligible
	Barrier	High	Negligible	Long-term	Negligible
Decommissioning	Displacement	Medium	Negligible	Medium	Negligible
Cumulative	All	High	Negligible	Long-term	Negligible

4.6.5 Conclusions

Habitats Appraisal

There are no SPAs for which wigeon is a qualifying species that will be affected by the proposed development.

Environmental Impact Assessment

Based on the relatively low numbers of wigeon recorded and their known behaviour it is predicted that there will not be a significant environment effect arising from the proposed development on wigeon.

4.7 Eurasian Teal *(Anas crecca)*

4.7.1 Protection and Conservation Status

The (Eurasian) teal is listed in Appendix II of the Bonn Convention, Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.7.2 Background

Teal		
GB Population	Summer: 155 – 2,600 prs. Winter: 192,000 ind.	BTO 2011
Scottish population	Summer: 1,950 – 3,400 prs. Winter – 22,500 – 125,000 ind.	Forrester *et al.* 2007
International threshold	5,000 ind.	Calbrade *et al.* 2010
GB threshold	1,920 ind.	Calbrade *et al.* 2010
Designated east coast sites where species is a noted feature	Loch of Strathbeg: 504 ind.	SNH 2011b Calbrade *et al.* 2010
European population estimate	Breeding: 920,000 – 120,000 ind. Wintering: >730,000 ind.	Birdlife 2004
European population trend	Status 'secure' Trend 'small decline'	Birdlife 2004
World population (Svalbard)	5,9 – 6,900,000 'adults'	Birdlife 2011

The teal is an uncommon breeding duck in the UK occurring on freshwater lochs and marshes. The majority of the UK population breed in Scotland where an estimated 3,400 pairs of teal breed (Forrester *et al*. 2007).

Following breeding, teal occur in both freshwater and coastal habitats feeding on seeds and grasses. There is a substantial increase in the numbers of teal in winter as migrants from northern Europe and Russia arrive during September and October and remain until March and April. About 6% of Scotland's wintering population of teal occur in North-east Scotland with most birds occurring on freshwater Lochs, e.g. Loch of Strathbeg and Loch of Skene. Elsewhere teal occur on the river Don where there may be up to 100 birds present.

Passage of teal past Peterhead occurs throughout the year but with a very distinct autumn passage with up to 550 birds during September. A smaller spring passage occurs during April and May. All sightings of teal made at Peterhead were of birds within a few hundred metres from the shore (Innes 1996).

Boat-based surveys

Three teal were seen from boat-based surveys with one in October and two in November.

Vantage Point surveys

Teal were infrequently recorded during the two years of vantage point surveys with a total of 36 birds recorded of which 26 were in September.

Bird Detection Radar

During the five days of observations undertaken at Easter Hatton and Drums during October 2005 as part of the Bird Detection Radar studies, 187 teal were recorded in seven flocks, all at Drums. (Walls *et al*. 2006). Additional studies undertaken over seventeen days in April 2007 observed seven teal at Blackdog (Simms *et al.* 2007).

4.7.3 Summary of Results

Aside from birds recorded from land-based counts at Drums in October 2005 relatively few teal were recorded during surveys undertaken in Aberdeen Bay.

4.7.4 Species Sensitivities

Qualifying species

The Loch of Strathbeg is the only SPA in the vicinity of the proposed development for which teal is a qualifying species.

Flight height

The only flight height recorded was of one bird flying at an altitude of between 25 m and 100 m.

Data from other UK offshore wind farms on flight heights for teal is very limited with records from a number of other offshore wind farms but the flight heights not being reported. There was one flock of 11 teal recorded at Beatrice Demonstration Project and all were flying at rotor height (Talisman 2005).

Collision risk

Teal were recorded across Aberdeen Bay in low numbers with peak counts occurring during periods of migration. Evidence from other offshore wind farms on the potential of collision risk is limited but a total of 2,300 teal were recorded during studies in Kalmar Sound and none were reported to collide. Evidence for other species of wildfowl indicates that wildfowl have high avoidance rates (Pettersson 2005; Peterson *et al.* 2006). The potential impacts from collision risk will be temporally long-term. Based on the low numbers of teal recorded within the proposed development area and the predicted high avoidance rates it is concluded that the risk of an adverse effect or significant environmental effect on teal from collision mortalities arising from the proposed development is negligible.

Barrier effect

Studies undertaken at Kalmar Sound suggest that there is the potential for some barrier effects as wildfowl avoid flying through wind farms. Teal may avoid flying through offshore wind farms and if so may incur an overall increase in flying distance of approximately 3.2 km. Site specific surveys did not record any regular feeding or roosting flights by teal across Aberdeen Bay and the seasonal occurrence of teal recorded suggest that the majority of birds are on migration. The relatively small additional distance flown should teal fly around the proposed development compared to the total distance of their migration to and from northern Europe and Russia will be negligible and long-term but not cause either a significant or an adverse effect.

Displacement

Teal do not use Aberdeen Bay for feeding or roosting and therefore no displacement effects will occur.

Cumulative and in-combination

The low level of usage of the site by teal and the relatively few recorded from other UK developments indicate that there will not be any cumulative or in-combination impacts.

Table 4-12: Summary of the significance of potential impacts on teal.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Medium	Negligible	Medium	Negligible
Operation	Collision	Medium	Negligible	Long-term	Negligible
	Displacement	Medium	Negligible	Long-term	Negligible
	Barrier	High	Negligible	Long-term	Negligible
Decommissioning	Displacement	Medium	Negligible	Medium	Negligible
Cumulative	All	High	Negligible	Long-term	Negligible

4.7.5 Conclusions

Habitats Appraisal

There are no SPAs for which teal is a qualifying species that will be adversely affected by the proposed development.

Environmental Impact Assessment

Based on the relatively low numbers of teal recorded and their known behaviour it is predicted that there will not be a significant environmental effect arising from the proposed development on teal.

4.8 Mallard (*Anas platyrhynchos*)

4.8.1 Protection and Conservation Status

The mallard is listed in Appendix II of the Bonn Convention Appendix III of the Bern Convention and is on the Green List of Species of Conservation Concern.

4.8.2 Background

Mallard		
GB Population	Summer: 48,000 – 114,000 prs. Winter – 352,000 ind.	BTO 2011
Scottish population	Summer: 17,000 – 43,000 prs Winter: 65,000 – 90,000 ind.	Forrester *et al.* 2007
International threshold	20,000 ind.	Calbrade *et al.* 2010
GB threshold	3,520 ind.	Calbrade *et al.* 2010
Designated east coast sites where species is a noted feature	Firth of Forth: 2,546 ind. (91/92-95/96)	SNH 2011b
European population estimate	Breeding: 920,000 – 120,000 ind. Wintering: >730,000 ind.	Birdlife 2004
European population trend	Status 'secure' Trend 'small decline'	Birdlife 2004
World population (Svalbard)	5,900,000 – 6,900,000 'adults'	Birdlife 2011

Mallard are the most common and widespread duck in Britain with a breeding population of up to 114,000 pairs and wintering population of approximately 352,000 individuals.

Mallard breed primarily on freshwater habitats but in winter occur widely on estuaries and shallow lochs (Forrester *et al.* 2007). Although the Scottish population is largely semi-resident, with only relatively localised movements, the wintering population is increased by migrants from Europe and Russia, which arrive during the autumn (Wernham *et al.* 2002). In North-east Scotland the main wintering areas are the Loch of Strathbeg and Loch of Skene with relatively small numbers of a hundred or less occurring on the Ythan Estuary (NESBR). Mallard were recorded throughout the year at Peterhead with a distinct peak in October and November when up to 500 birds were recorded (Innes 1996).

Boat-based surveys

Two mallard were recorded in January 2008, two in September 2010 and one in November 2010.

Vantage Point surveys

Mallard were infrequently recorded in Aberdeen Bay during the two years of vantage point surveys with a total of 52 birds counted. There was no obvious seasonal variation in the small numbers of counts made, with 33 birds in June 2006 being the biggest count.

Bird detection Radar

No mallard were recorded from radar studies undertaken in October 2005 but nine were recorded at Blackdog during the surveys undertaken in April 2007 (Simms *et al.* 2007).

4.8.3 Summary of Results

Mallard were infrequently recorded in Aberdeen Bay with most sightings from vantage point surveys.

4.8.4 Species Sensitivities

Qualifying species

There is one SPA in the region for which mallard is part of the qualifying assemblage: Firth of Forth SPA.

Flight height

Very few records of mallard were made from site specific boat-based or land-based surveys and no records of their flight heights were made.

There are very limited data from other UK offshore wind farms on flight heights for mallard with only six recorded flight heights from surveys undertaken at ten offshore wind farms. Of those recorded; 33% of flights were at rotor height.

Collision risk

Site specific monitoring indicated that mallard are scarce in Aberdeen Bay and primarily occur in near-shore waters. Evidence from other offshore wind farms indicated that mallard are at low risk of collision from offshore wind farms. A total of nearly 5,500 mallard were recorded during studies undertaken in Kalmar Sound and no collisions were recorded (Pettersson 2005). Based on the relatively low numbers of mallard recorded and evidence of a potentially high avoidance rate from other developments where mallard are relatively more common, it is predicted that the risk of an adverse or significant environmental effect on mallard from collision mortalities arising from the proposed development is temporally long-term and of negligible magnitude and minor significance.

Barrier effect

Studies undertaken at Kalmar Sound suggest that there is the potential for some barrier effects as mallard may avoid flying through offshore wind farms (Pettersson 2005). Should a barrier effect occur then mallard will fly around the proposed development. This may incur an overall increase in flying distance of approximately 3.2 km. Site specific monitoring did record any regular feeding or roosting flights by mallard across Aberdeen Bay nor any regular usage of the site itself. North-east Scotland Bird Reports (NESBR) do not report any such usage. Any additional distance flown, should mallard fly around the proposed development, will likely be small compared to the total distance of their potential migration or, based on the site specific data, only occasional and will be temporally long-term but not significant or have an adverse effect.

Displacement

Mallard do not use Aberdeen Bay for feeding or roosting (NESBR) and therefore no displacement effects will occur.

Cumulative and in-combination

The low level of usage of the site by mallard and the relatively few recorded from other UK developments indicate that there will not be any cumulative or in-combination impacts.

Table 4-13: Summary of the significance of potential impacts on mallard.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Medium	Negligible	Medium	Negligible
Operation	Collision	Very High	Negligible	Long-term	Minor
	Displacement	Medium	Negligible	Long-term	Negligible
	Barrier	High	Negligible	Long-term	Negligible
Decommissioning	Displacement	Medium	Negligible	Medium	Negligible
Cumulative	All	High	Negligible	Long-term	Negligible

4.8.5 Conclusions

Habitats Appraisal

There are no SPAs for which mallard is a qualifying species that will be affected by the proposed development.

Environmental Impact Assessment

Based on the relatively low numbers of mallard recorded and their known behaviour it is predicted that there will not be a significant environmental effect arising from the proposed development on mallard.

4.9 Common eider (*Somateria mollissima*)

4.9.1 Protection and Conservation Status

The (common) eider is listed in Appendix II of the Bonn Convention, Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.9.2 Background

Eider		
GB Population	Summer: 31,000 pairs. Winter: 73,000 ind.	BTO 2011
Scottish Population	Summer: 20,000 nesting females Winter: 64,500 ind.	Forrester *et al.* 2007
International threshold	12,850 ind.	Calbrade *et al.* 2010
GB threshold	550 ind.	Holt *et al.* 2011
Designated east coast sites where species is a noted feature	Ythan Estuary Montrose Basin Firth of Tay and Eden Estuary Firth of Forth	SNH 2011b JNCC 2011a
European population estimate	Breeding: 840,000 – 1,200,000 prs. Wintering: 1,700,000 ind.	Birdlife 2004
European population trend	Status 'secure' Trend 'small decline'	Birdlife 2004
World population	3.1 – 3,800,000 'adults'	Birdlife 2011

Eiders occur in coastal waters throughout northern Britain, particularly in shallow water of usually less than 3 metres where suitable prey of molluscs and crustaceans. Breeding colonies are often large and flocks of many thousands of birds can occur in suitable nearshore areas. It is the commonest breeding seaduck in the UK with a breeding population of 31,000 pairs of which approximately 20,000 occur in Scotland (BTO 2011; Forrester *et al*. 2007).

Following breeding, eiders may congregate into large moulting flocks in specific areas with main areas in eastern Scotland being Firth of Forth, Shetland, Ythan, Aberdeen Bay and Montrose Basin (Cork Ecology 2004a). The largest moulting flock occurs off Murcar, in Aberdeen Bay, where up to 9,000 individuals have been recorded (Forrester *et al.* 2007).

Although eiders in the UK are largely non-migratory there is some winter dispersal away from the breeding areas with a proportion of birds from North-east Scotland wintering in the Tay Estuary. The east coast of Scotland holds a substantial proportion of the UK wintering population with approximately 59,000 birds. The major wintering areas along the east coast of Scotland are the Tay Estuary, Firth of Forth, Montrose Basin, Orkney, Ythan and the Moray Firth (Cork Ecology 2004a). First winter birds remain near the Ythan Estuary (Baillie and Milne 1988).

The most important breeding area for eider in North-east Scotland is the Ythan Estuary and neighbouring coasts, where up to 1,500 'pairs' of eider breed (based on the number of females present) and is the highest concentration of breeding eiders in Britain (Patterson, 2011). Peak counts at the Ythan Estuary occur during May with maximum counts of up to 4,952 in 2004 and a five year peak mean of 3,404 individuals (NESBR, Holt *et al*. 2011) (Figure 4-4). This is lower than the numbers present on the estuary during the 1980s when between 6,000 and 7,000 eider were recorded (Buckland, Bell and Picozzi 1990; Patterson 2011). Since 2004 the numbers of eider present on the Ythan has decreased to about 2,500 individuals in recent years (NESBR, RSPB 2011). Peak numbers of eider recorded in Aberdeen Bay are generally lower than those recorded on the Ythan with generally between 1,000 – 2,000 birds present, although numbers have increased with a peak count of 4,200 in August 2010 being the highest (NESBR; RSPB 2011). Overall, numbers of eider present in Aberdeen Bay have decreased since the peak counts in the 1980s when over 9,000 were recorded there every August (Buckland, Bell and Picozzi 1990; NESBR). Recent offshore counts report the number of eider in Aberdeen Bay as being 5,302 and 6,269 (2005/2006) (Holt *et al*. 2011).

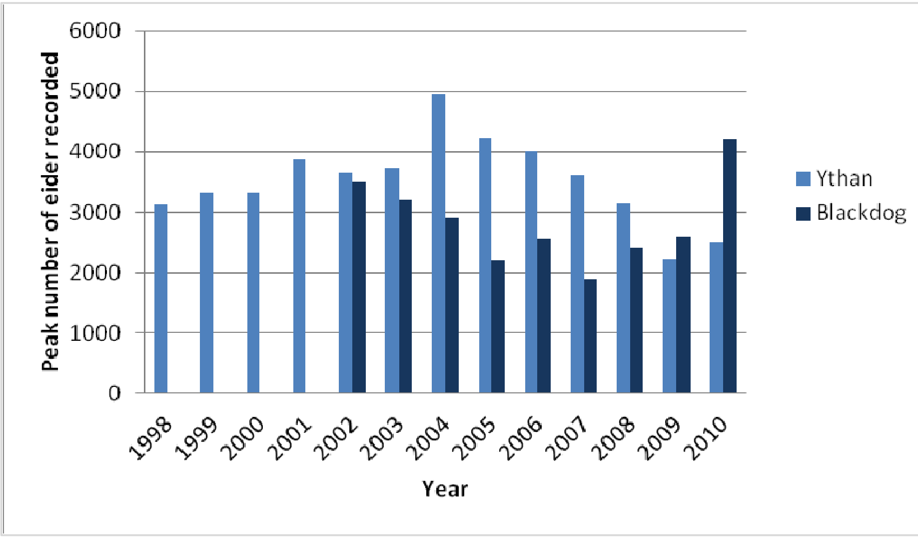


Figure 4-4: Peak eider counts at Ythan Estuary and Blackdog 1998 – 2010 (Source NESBR and RSPB 2011).

There is recognised to be two separate breeding populations of eider on the Ythan Estuary with birds resident in the area throughout the year pairing and breeding with other resident individuals. Whereas, a proportion of birds migrate to the Firth of Tay for the winter period and pair and breed with individuals that also migrate to the Tay. These migratory individuals breed primarily along the coast compared to the resident birds that breed primarily adjacent to the Estuary (Gibbins and Maggs 2008; Milne 1965).

Eiders are recorded passing Peterhead throughout the year but there is a strong seasonal variation with a marked spring passage of birds moving north of up to 175 birds per hour in March. The peak count reported is of 3,000 birds over three hours in April 1982; a year when over 30,000 eider were counted flying north between February and April (Buckland, Bell and Picozzi 1990; Innes 1996). There is a smaller movement of birds in the autumn of up to 100 birds per hour during October. Although eider occurred out to 3 km from shore, the majority of sightings were within several hundred metres from the coastline (Innes 1996).

Boat-based surveys

Common eiders were recorded throughout the year in inshore shallow waters predominantly in water depths of less than 10 m (Appendix B). The majority of sightings were of birds outwith the 300 metre transect with only 77 birds 'in transect' and no records of eider 'in transect' during June, July and August. Consequently, the population estimates are under-representative to the total number of birds that may be present in the area. Maximum counts of common eider outwith the survey area were at Blackdog where 450 birds were present in September 2007 and 434 in September 2010 (SMRU 2011b).

The boat-based survey data indicate that the majority of eider occur in waters less than 20 m deep and in particular, less than 10 m. There were no records of eider within the proposed development area with the majority of eider to the south-west in near-shore waters approximately 1 km from the nearest potential turbine location.

Table 4-14: Seasonal estimates of density and abundance of eider in the EOWDC and 'control' Areas based on Year 1 boat data.

	Density Estimate (km^2)	S.E	Estimated Abundance	S.E.	Number of obs.
Development - winter	10.95	35.08	556	1.78	3
Control -winter	0.31	0.19	16	10	5
Development - Spring	0.12	0.07	6	3.8	6
Control - Spring	0.00	0.00	0	0.0	0
EOWDC - Summer	0.00	0.00	0	0	0
Control - Summer	0.00	0.00	0	0.0	0
EOWDC - Autumn	0.03	0.00	2	0.2	1
Control - Autumn	0.36	0.29	19	14.8	2

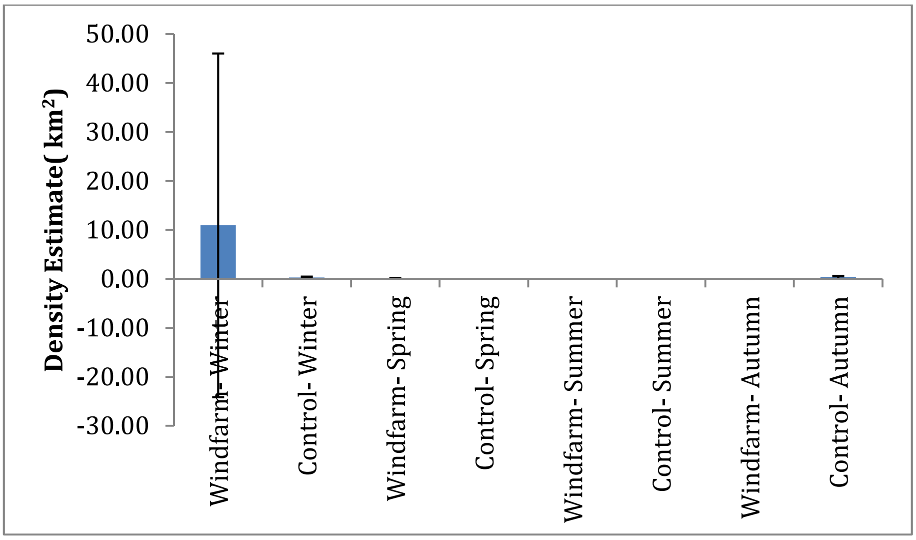


Figure 4-5: Seasonal estimates (+/- SE) of density of eiders in the proposed EOWDC and 'control' Areas – Year 1.

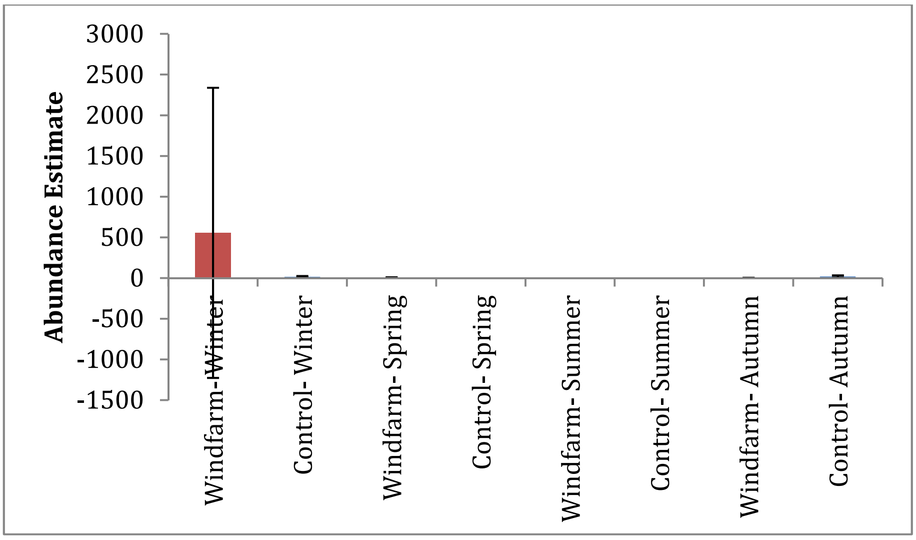


Figure 4-6: Seasonal estimates (+/- SE) of abundance of eiders in the proposed EOWDC and 'control' Areas – Year 1.

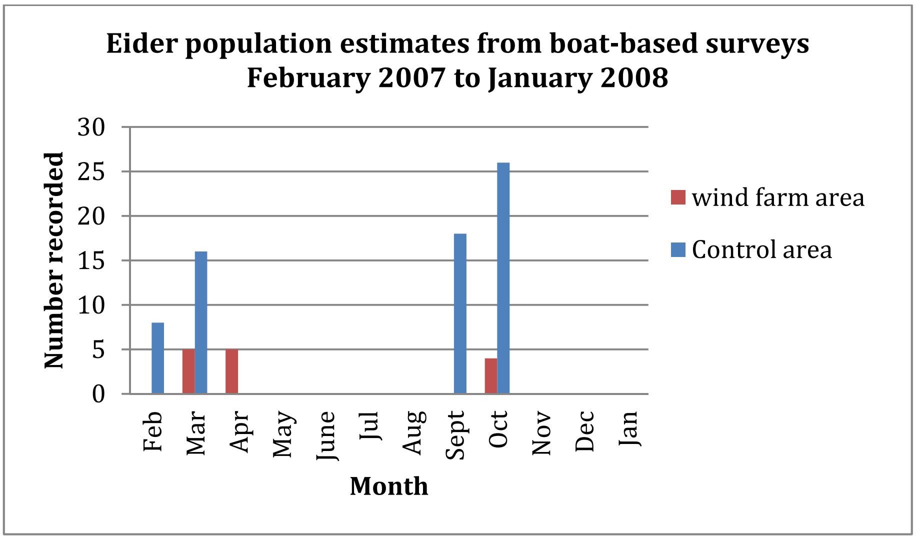


Figure 4-7: Common eider monthly population estimates in proposed EOWDC and 'control' areas: Boat-based surveys 2007 – 2008.

Table 4-15: Common eider monthly population estimates in Aberdeen Bay: Boat-based surveys 2007 – 2008.

Month	On water estimate	In flight estimate	Total estimate
February	8	0	8
March	0	21	21
April	5	0	5
May	0	0	0
June	0	0	0
July	0	0	0
August	0	0	0
September	18	0	18
October	27	3	30
November	0	0	0
December	0	0	0
January	0	0	0

Boat-based surveys undertaken between August 2010 and August 2011 recorded eider between February and November, with no sightings in December and January and none during the breeding season from May, June and July. Peak numbers occurred between August and October with a total of 450 eiders counted in 2011.

There were not enough observations to undertake Distance analysis for eider alone. However, combined totals with other seaduck provided a peak density estimate of 16.17 seaduck/km^2 during September 2010 (Figure 4-8) and a total estimated abundance of 2,438 individuals in the northern strata (Figure 4-9). Elsewhere in Aberdeen Bay very few eider (or other seaduck) were recorded from Year 2 boat-based surveys with one sighting in March 2010 to the south of the surveyed area and no sightings in the offshore areas (SMRU 2011c).

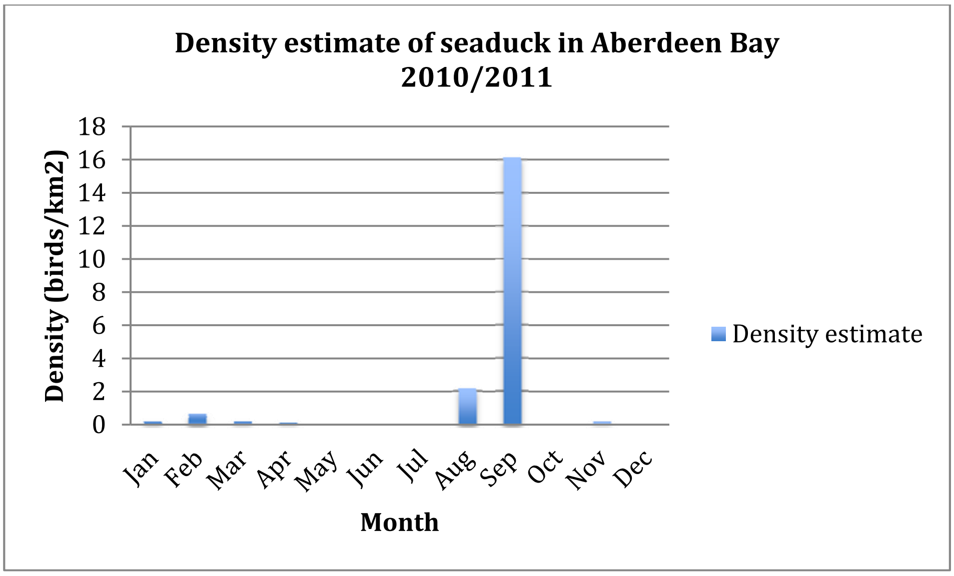


Figure 4-8: Seaduck density estimates in northern strata of Aberdeen Bay from boat-based surveys in 2010/2011

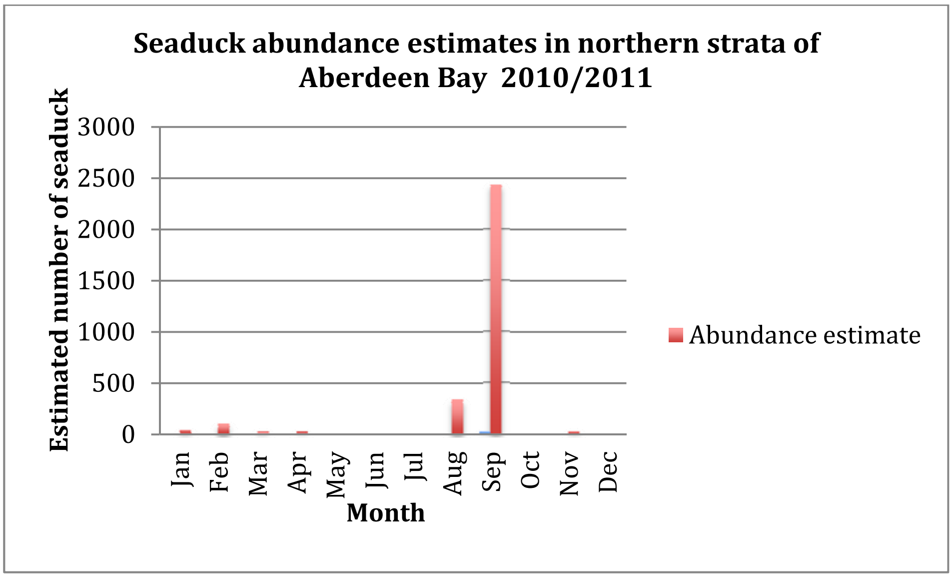


Figure 4-9: Seaduck abundance estimates in northern strata of Aberdeen Bay from boat-based surveys in 2010/2011.

Vantage Point surveys

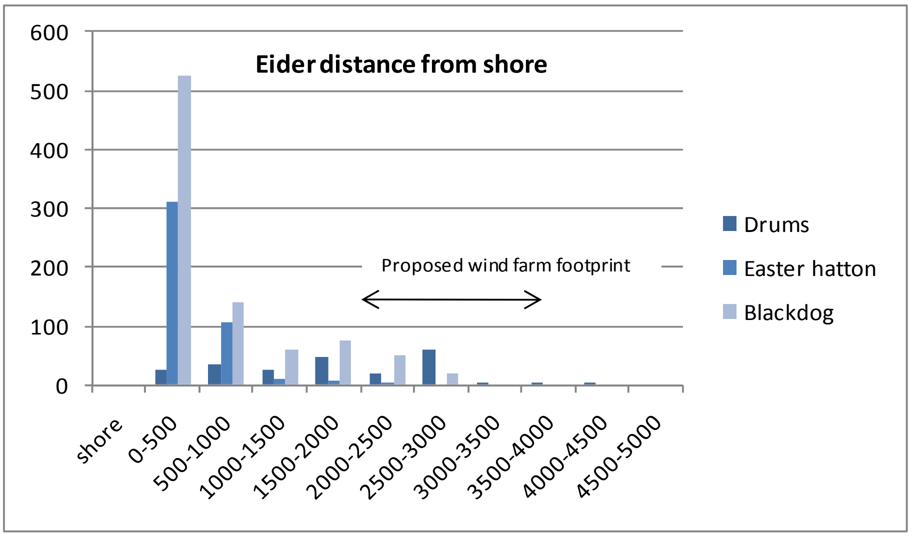
Peak movements of eider in Aberdeen Bay occurred during dawn and dusk with up to 10 birds per hour between December and March and increasing up to 32 birds per hour passing in April 2007 before decreasing to mainly less than 10 birds per hour from June through to August (EnviroCentre 2007; Alba Ecology 2008a,b).

Between 96% and 98% of all flights were below 30 m with the majority of observations within 2 km of the coast and fewer between 2 km and 3 km away. Highest numbers were consistently recorded at Balmedie and Drums, which were the two closest vantage point sites to the Ythan Estuary.

Bird Detection Radar

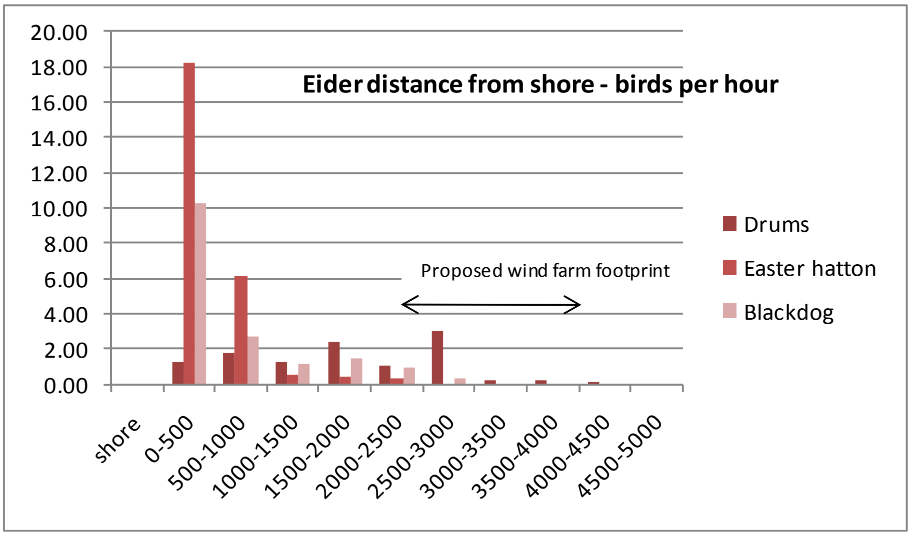
Eider were frequently recorded during the radar studies undertaken in October 2005. A total of 680 birds were recorded, of which 449 were at Easter Hatton and 231 at Drums. Of those recorded in flight the maximum flight height was 10 m with the mean flight height of between 2 m and 3 m (Walls *et al*. 2006).

Additional studies undertaken in April 2007 recorded 855 eider at Blackdog and of those recorded in flight, all were below 30 m. All sightings were of birds within 3 km from shore with the majority being within 500 m (Figure 4-10) (Simms *et al.* 2007).



(Adapted from Walls *et al.* 2006, Simms *et al.* 2007)

Figure 4-10: Distances from shore for common eider from three locations in Aberdeen Bay during surveys undertaken in October (Drums and Hatton) and April (Blackdog).



(Adapted from Walls *et al*. 2006, Simms *et al*. 2007).

Figure 4-11: Number of common eider per hour and distance from shore from three locations in Aberdeen Bay during surveys undertaken in October (Drums and Hatton) and April (Blackdog).

4.9.3 Summary of Results

The Ythan Estuary and Aberdeen Bay are both important areas for eider throughout the year. The Ythan Estuary is the largest breeding colony of eider in the UK and Aberdeen Bay holds nationally important numbers, particularly during the post-breeding period of July and August.

The results from boat-based surveys recorded relatively few eider, with peak numbers during the autumn periods. In Year 1 and Year 2, no eider were recorded within transect in either the proposed EOWDC area or the 'control' area between May and July. Peak densities occur during September. Data from land-based observations recorded peak numbers of eider between December and April with a peak, in April, of up to 32 birds per hour passing across the bay. Eider were recorded out to at least 3 km from shore but a significant majority of sightings were within 1 km from shore.

All those recorded in flight from boat-based surveys were flying below 25 m and of those recorded from shore more than 96% were flying below 30 metres.

The breeding population on the Ythan Estuary and the number of birds using Aberdeen Bay are of national importance.

4.9.4 Species Sensitivities

Qualifying species

There are four SPAs in the region for which eider is a qualifying species as part of waterfowl assemblages: Ythan Estuary, Sands of Forvie and Meikle Loch SPA, Montrose Basin SPA and Ramsar, Firth of Forth SPA and Firth of Tay and Eden Estuary SPA.

Flight height

Flight heights obtained from boat-based surveys undertaken in Aberdeen Bay recorded one eider flying at 25 m and therefore at risk of potential collision.

Elsewhere in the UK there is very limited data from offshore wind farms on flight heights for eider although extensive studies undertaken in Denmark and Sweden have recorded significant numbers of eider. Based on modelling results and a minimum rotor blade height of 20 m the proportion of eider flying at rotor height is overall 2.0%, with a mean flight height of 13.7 m (n=34,513) (Cook *et al*. 2012).

Collision risk

Site specific monitoring using boat-based and land-based surveys and other data sources indicate that eider are widespread and frequent within Aberdeen Bay. They occur widely with the majority of sightings occurring in nearshore waters within 1 km of the shore and in water depths of <20 m.

In order to determine potential effects of collision on eider a collision risk assessment has been undertaken (Appendix A1).

The collision risk modelling (CRM) predicts less than one eider per year may collide with the proposed development depending on the avoidance rate selected and use of site specific or generic modelled data (Table 4-16).

Table 4-16: Eider predicted collision mortalities per year.

Rochdale	Flight height data source	Avoidance rate (%)			
		95.0	98.0	99.0	99.5
Original	EOWDC	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00
	Generic	0 +/- 0.22	0 +/- 0.09	0 +/- 0.04	0 +/- 0.02
Revised	EOWDC	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00
	Generic	0 +/- 0.22	0 +/- 0.09	0 +/- 0.04	0 +/- 0.02

Based on the precautionary avoidance rate of 98% it is predicted that there will be less than one collision per year.

Studies undertaken in Denmark indicate that eider have a very high avoidance rate and that the majority of birds will detour around the wind farm. Birds flying within wind farms are unusual and when doing so, 89% of all flights are below turbine height. Modelling undertaken for the significantly larger Nysted Offshore wind farm predicted that out of 235,000 passing eiders, between 0.018 and 0.02 birds might collide with a turbine (Petersen *et al*. 2006).

In Sweden, at two wind farms in the Kalmar Sound, eiders are the most abundant species and over 1.2 million eider were recorded during the study period, of which three were seen to collide with the turbines (Pettersson 2006).

Consequently, there is substantial volume of evidence to indicate that the risk of collision by eider is extremely low.

The numbers of eider recorded in Aberdeen Bay are significantly lower than those recorded in Denmark and Sweden and from studies undertaken at these sites there were no reports of any significant impact from collision. Furthermore, site specific data indicates that relatively few eider in Aberdeen Bay occur beyond 2 km of the coast and that none have been recorded flying at rotor height from boat-based surveys. Site specific studies indicated up to six times more eider passing within 500 metres from shore compared to between 2.5 km and 3 km from shore (Simms *et al.* 2007).

Based on the results from other offshore wind farms that have demonstrated significant avoidance rate and very low risk of collision as well as the relatively low usage of the site it is concluded that the potential effect from collision risk on eider is temporally long-term and of negligible magnitude and minor significance.

Barrier effect

Studies undertaken in Sweden and Denmark have shown that there is the potential for significant barrier effect, with eiders changing flight directions at least 1 km from offshore wind turbines and flying around them (Petersen *et al*. 2006; Pettersson 2006). At Nysted offshore wind farm in Denmark radar studies undertaken tracked over 300,000 eider each autumn. The results indicated that there was a significant decrease in the proportion of flocks entering the wind farm from between the pre-construction period and the operational period. It was found that, post construction, 9% of the birds entered the turbines compared with 40% crossing the same location before construction, i.e. there was a clear tendency for flocks to alter course and avoid the wind farm. Flocks that did continue into the wind farm adjusted their flight trajectories and tended to fly down the visually clear corridors between the rows of turbines (Deshom and Kahlert 2005). Further monitoring at Nysted reported a reduction of between 63% and 83% in the use of the wind farm airspace by migrating birds post construction, compared to preconstruction (Petersen *et al.* 2006), providing evidence of large-scale avoidance behaviour of migrating birds as a whole.

Therefore, it is predicted that the proposed development has the potential to cause a barrier effect to eiders in Aberdeen Bay.

Regular daily movements of eider within Aberdeen Bay to and from feeding or roosting areas have not been recorded from vantage point surveys or boat-based surveys. Nor have there been any reports in published literature (e.g. NESBR). Should barrier effects occur, with eider making daily movements from the Ythan Estuary to Aberdeen Bay to the south of the proposed development and the birds choose to fly around the turbines from up to 1 km away then therefore incur an additional flight distance of up 3.2 km each way, or a total of 6.4 km. This may increase the daily energy expenditure to between 2.0% and 2.5% (Caldrow, Stillman and West 2007; Speakman, Gray and Furness 2009). This is a relatively small increase in daily energy expenditure and is unlikely to have an adverse effect on eiders in Aberdeen Bay although the potential impacts arising from increases in energy expenditure depend on the individual's fitness.

The peak numbers of eider in Aberdeen Bay occur during July and August (NESBR). During this period adult eider undergo a complete wing moult over a period of approximately four weeks, during which time they become flightless. The daily energetic costs during this period increase but the birds remain within certain areas where they can forage and do not undergo daily flight movements (Guillemette *et al.* 2007). Consequently, there is no incremental increase in daily energy expenditure due to the potential barrier effect during this period of higher energy expenditure.

Data obtained from two years of vantage point surveys did not detect any regular daily flights by eider across the proposed development area and so a regular barrier effect that may cause a long-term increase in daily energetic costs is not predicted. There is the potential for a relatively small *ad hoc* increase as birds move around the bay but as most movements are within 1 km of the coast regular barrier effects are unlikely (Figure 4-10). It is predicted that the possible impacts arising from a potential barrier effect will be of low magnitude and temporally long-term minor significance but not cause an adverse effect or significant environmental impact.

Displacement

Peak eider density within the surveyed area that includes the proposed EOWDC site was 16.17 birds/km^2 during the post-breeding season (Figure 4-8). Based on the peak densities recorded, should there be a total displacement of eider from within the proposed development area then it is predicted that up to 69 eiders may be displaced from the proposed development area during periods of peak density.

Eider were considered to be at low risk of displacement in the review undertaken by Langston on the potential impacts of wind farms (Langston 2010). Based on this review, a low displacement of between 10% and 30% of eider has been considered for this assessment (Table 4-17).

Based on the assumptions made that there may be up to 20% displacement then between 1 and 14 eider may be impacted due to displacement from with the proposed development area alone.

Based on the assumptions made that there may be up to 20% displacement then between 10 and 104 eiders may be impacted due to displacement should displacement occur out to 2 km.

Based on the maximum estimated total of 104 potentially displaced eider out of a peak reported count of 4,200 eider at Blackdog in 2010 (Figure 4-4), it is predicted that up to 2.4% of the eider within Aberdeen Bay may be displaced. However, the distribution of eider within Aberdeen Bay is clustered with peak numbers occurring at various sites across the bay during different seasons (Söhle *et al*. 2006). The area off Blackdog regularly records the peak counts of eider in Aberdeen Bay (NESBR) and should displacement occur a greater proportion of eider might be affected than is estimated using densities obtained from boat-based surveys.

Eider counts published in the North-east Scotland Bird Reports indicate that peak counts within the bay may be higher than those reported from boat-based surveys (Figure 4-4). The highest count of eider in recent years is of 4,200 individuals in August 2010 (NESBR; RSPB 2011).

The total area of Aberdeen Bay from Collieston to Aberdeen and out to 4 km is approximately 95 km^2 and therefore a peak density of 46 eider/km^2 may occur across the bay.

Based on densities of eider derived from land based observations and published in the North-east Scotland Bird Report and assuming that up to 20% of eider may be displaced, then between 0 and 40 eider may be impacted from the proposed development area and between 0 and 509 individuals, if displacement occurs out to 2 km (Table 4-17 and Table 4-32).

It is recognised that eiders are not evenly distributed across the bay and form large flocks in nearshore waters, therefore densities will vary considerably across the bay.

The Tuno Knob offshore wind farm in Denmark is a relatively small wind farm of ten turbines in an area that holds up to 5,800 eider. Post-construction monitoring at Tuno Knob has indicated that the distribution of eider is closely related to their prey and although there may be some displacement immediately post-construction there is unlikely to be any significant displacement of eider from the proposed development area as long as their prey remains available (Guillemette *et al.* 1999). Evidence from studies undertaken at Nysted offshore wind farm have indicated that although there was an avoidance of the area during construction there was a subsequent increase of 48% within the wind farm area post-construction but a decrease in numbers out to 2 and 4 km (Zucco *et al.* 2006). Therefore, indicating an attraction to the area compared to adjacent waters.

These two studies indicate that eiders do not avoid wind farms post-construction and their distribution is closely aligned to the availability of prey. The main prey items for eider are mussels (*Mytilus edulis*). Evidence from constructed wind farms indicates that there is likely to be an increase in mussels around the base of turbines and that no significant impacts have been detected on mussels from the construction of wind farms (e.g. Maar *et al.* 2009). Consequently, there is unlikely to be a negative impact on prey availability for eiders within Aberdeen Bay.

Based on the evidence from existing offshore wind farms it is predicted that the potential impact from displacement is of negligible magnitude, long-term but of minor significance and not cause a significant effect.

Disturbance

Eiders may be disturbed by vessels both during the construction phase and during operations from maintenance vessels. Studies have indicated that there may be displacement from large vessels out to 1,000 m (Larsen and Laubek 2005).

During construction there may be a number of vessels operating within the area but they will likely be focussed around a single point where the turbine is being installed. Consequently, eider may be displaced from within a 1 km radius of the installation; an area of 3 km^2. Based on the highest recorded density of 16.17 birds/km^2, it is therefore predicted that up to 49 eider may be displaced from the vicinity during construction. This equates to approximately 1.1% of the peak eider population within Aberdeen Bay based on the peak reported count of 4,200 individuals. The construction period will be of medium duration and the impacts from construction vessels temporary. Consequently, any potential impact is predicted to be short to medium-term and of negligible magnitude and minor significance.

Displacement by service boats may diminish the re-population potential of the EOWDC. It is not known exactly how many service vessels may be required but based on the scale of the proposed development there is unlikely to be more than four vessels on any one occasion during the period of operation. The presence of the proposed development in the vicinity of the intensively used Aberdeen Harbour means that the potential increase of between one and four vessel operations on a regular basis will not have any noticeable difference to the number of vessels already using Aberdeen Bay. Any specific displacement caused by the service or construction boats will be temporary as eiders will be able to move into the area once the vessels leave.

Proposed mitigation will include the development and implementation of a plan that will manage vessel movements to and from the proposed EOWDC. By doing so, the potential and scale of disturbance on eider will be minimised.

It is concluded that the effect of disturbance from construction or service boats is short to long-term and of negligible magnitude and minor significance.

Table 4-17: Potential number of eider displaced by the proposed development based on boat-based data and land-based (NESBR) observations.

% Impacted	Displacement (development area) Boat-based data			Displacement (development area + 2 km buffer) Boat-based data			Displacement (development area) NESBR data			Displacement (development area + 2 km buffer) NESBR data		
	10%	20%	30%	10%	20%	30%	10%	20%	30%	10%	20%	30%
0%	0	0	0	0	0	0	0	0	0	0	0	0
10%	0.69	1.38	2.07	5.22	10.44	15.66	2.00	4.00	6.00	16.97	33.94	50.91
20%	1.38	2.76	4.14	10.44	20.88	31.32	4.00	8.00	12.00	33.94	67.88	101.82
30%	2.07	4.14	6.21	15.66	31.32	46.98	6.00	12.00	18.00	50.91	101.82	152.73
40%	2.76	5.52	8.28	20.88	41.76	62.64	8.00	16.00	24.00	67.88	135.76	203.64
50%	3.45	6.90	10.35	26.10	52.20	78.30	10.00	20.00	30.00	84.85	169.70	254.55
60%	4.14	8.28	12.42	31.32	62.64	93.96	12.00	24.00	36.00	101.82	203.64	305.46
70%	4.83	9.66	14.49	36.54	73.08	109.62	14.00	28.00	42.00	118.79	237.58	356.37
80%	5.52	11.04	16.56	41.76	83.52	125.28	16.00	32.00	48.00	135.76	271.52	407.28
90%	6.21	12.42	18.63	46.98	93.96	140.94	18.00	36.00	54.00	152.73	305.46	458.19
100%	6.90	13.80	20.70	52.20	104.40	156.60	20.00	40.00	60.00	169.70	339.40	509.10

Cumulative and in-combination

The potential future Ocean Laboratory will require additional vessel movements within the proposed development area. Should this occur then there is the potential for a cumulative effect on eider. It is not yet known what type of structure the Ocean Laboratory may be or how it will be installed or the exact number of vessel movements required. However, during operations it is predicted that vessel movements to the laboratory will be infrequent and in the order of one per every twelve weeks. The scale of disturbance is therefore predicted to be localised and of short duration.

Aside from the historical and on-going levels of shipping, there are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts. A proportion of the eiders present in Aberdeen Bay and the Ythan Estuary are known to travel to the Tay during the winter and have the potential to interact with other offshore wind farms planned in the area. However, the location of the wind farms in the Firth of Forth area, in particular their distance from shore, are such that eiders are unlikely to be frequently recorded in any of the areas of the proposed developments. Consequently, there are unlikely to be any cumulative or in-combination impacts.

Table 4-18: Summary of the significance of potential impacts on eider.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Very High	Negligible	Medium	Minor
Operation	Collision	Very High	Negligible	Long-term	Minor
	Displacement	Very High	Negligible	Long-term	Minor
	Barrier	High	Low	Long-term	Minor
Decommissioning	Displacement	Very High	Negligible	Medium	Minor
Cumulative	All	Very High	Negligible	Long-term	Minor

4.9.5 Conclusions

Habitats Appraisal

Based on the monitoring from existing offshore wind farms indicating both a very low collision risk and little, if any, displacement and that there are not expected to be any significant barrier effects and there will not be any adverse effects on the SPAs for which eider is a qualifying species.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental effect arising from the proposed development on eider.

4.10 Long-tailed duck (*Clangula hyemalis*)

4.10.1 Protection and Conservation Status

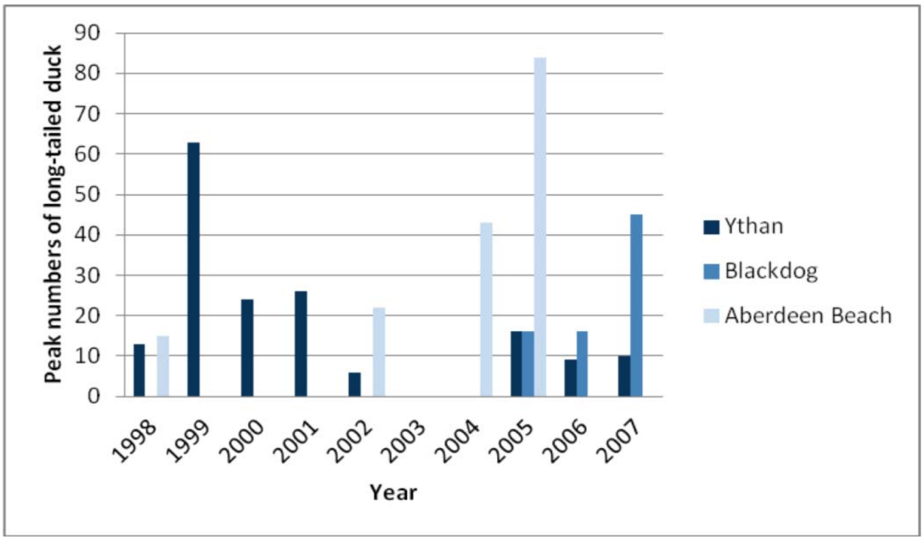
Long-tailed duck is listed in Appendix II of the Bonn Convention, Appendix III of the Bern Convention and is on the Green List of Species of Conservation Concern.

4.10.2 Background

Long-tailed duck		
GB Population	Winter: 16,000 ind.	BTO 2011
Scottish Population	Winter: 15,000 ind.	Forrester *et al* 2007
International threshold	20,000 ind.	Calbrade *et al.* 2010
GB threshold	110 ind.	Holt *et al*. 2011
Designated east coast sites where species is a noted feature	Firth of Forth Firth Tay and Eden Estuary	SNH 2011b
European population estimate	Breeding: 7,669 – 17,294 pairs Wintering: 4,700,000 individuals	Hagemeijer and Blair 1997
European population trend	Status 'decreasing' Trend 'moderate decline	Birdlife 2004
World population	6.2 to 6,800,000 ind.	Birdlife 2011

Long-tailed duck breed in the high Arctic with significant breeding populations in Russia where up to 5 million pairs are estimated to breed. In north-west Europe, breeding populations are considerably smaller with less than 18,000 pairs in Sweden, Iceland and Finland. Long-tailed duck do not breed in the UK but an estimated 16,000 individuals winter in the UK of which 15,000 winter in Scottish waters, primarily in Shetland, Orkney and the Moray Firth (Forrester *et al.* 2007). Outwith the breeding season long-tailed duck occur along sheltered coasts, often with soft sandy sediments and can dive to depths of up to 60 metres so can occur further offshore than many other species of seaduck.

In north-east Scotland long-tailed duck are an uncommon winter visitor with most sightings and peak numbers occurring in Aberdeen Bay where less than a hundred birds may occur (Figure 4-12). Other areas in the region with relatively high numbers of long-tailed duck are Cruden Bay to the north and the Donmouth to the south of the bay. Passage of birds passing Peterhead occurred from September to May with peak counts of up to 14 birds per hour during March. Although most sightings at Peterhead were within a few hundred metres from the shore long-tailed duck were seen as far out as 3 km (Innes 1996).



(Source NESBR)

Figure 4-12: Peak numbers of long-tailed duck recorded at the Ythan, Blackdog and Aberdeen Beach 1998 – 2008.

Boat-based surveys

Long-tailed duck were infrequently recorded from ship-based surveys with the majority of sightings during the winter period. All sightings of long-tailed duck were of birds close inshore, flying parallel to the coast. There were no sightings of birds within the proposed development area (Appendix B) (IECS 2008, SMRU 2011b, 2011c).

There was a strong seasonal occurrence of long-tailed duck in Aberdeen Bay with birds recorded between October and March with peak encounter rates of up to 0.1 birds/km travelled during February (Figure 4-13).

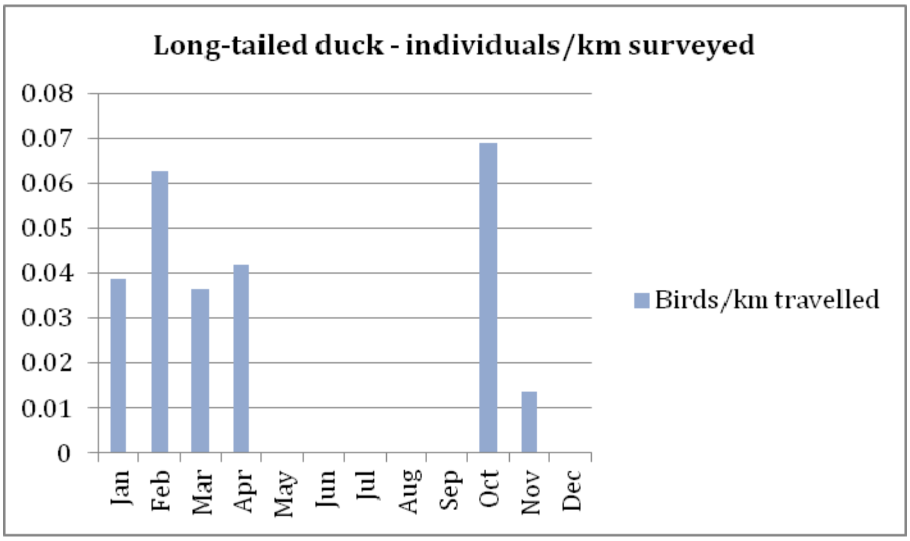


Figure 4-13: Encounter rates of long-tailed duck in Aberdeen Bay from two years of boat-based surveys

Vantage Point surveys

Long-tailed duck were regularly recorded in low numbers within Aberdeen Bay, primarily between December and March with a peak count of up to 25 birds per hour passing Blackdog in November 2007. However, numbers passing were usually less than five birds per hour at other sites (Alba Ecology 2008b). All birds were recorded flying below 30 m with the majority of sightings between 1 km to 3 km from shore (Alba Ecology 2008b).

Bird Detection Radar

A total of 17 long-tailed duck were observed during the studies in October 2005 with seven at Drums and ten at Easter Hatton. Although long-tailed duck were recorded out to 2.7 km from shore the majority of sightings were within 2 km from the coast. The mean flight heights were 2 m above sea surface with the maximum height of 4 m (Walls *et al*. 2006). Forty-seven birds were recorded during studies undertaken at Blackdog in April 2007. All birds were flying below 30 m and 90% of sightings were within 1.5 km of the coast (Simms *et al.* 2007).

4.10.3 Summary of Results

Relatively small numbers of long-tailed duck occur in Aberdeen Bay with peak counts of usually less than 50 birds, occurring in any month between November and March. Although long-tailed duck can occur throughout the bay the main areas are the Ythan mouth, Blackdog and the Donmouth. The majority of sightings are of birds within 2 km of the shore and at least 90% of the birds recorded in flight were flying below 30 m.

No counts of long-tailed duck within Aberdeen Bay were of national importance.

4.10.4 Species Sensitivities

Qualifying species

There are two SPAs in the region for which long-tailed duck is a qualifying species as part of waterfowl assemblages: Firth of Forth SPA and Firth of Tay and Eden Estuary SPA.

Flight height

Flight heights obtained from boat-based surveys undertaken in Aberdeen Bay recorded twenty long-tailed ducks for which flight heights were recorded as flying below 25 m. Data from site specific studies recorded a mean flight height of 2 m and a maximum of 4 m (Walls *et al*. 2010).

Collision risk

Site specific monitoring using boat-based and land-based surveys and other data sources indicate that long-tailed duck occur in relatively low numbers within Aberdeen Bay. Studies undertaken in Sweden indicate that long-tailed duck have a very high avoidance rate and that the majority of birds will either detour around the wind farm or fly below turbine height (Pettersson 2006). Consequently, the risk of collision by long-tailed duck is extremely low.

The numbers of long-tailed duck recorded in Aberdeen Bay were significantly lower than those recorded during the studies undertaken in Sweden where no significant impacts from collision were recorded.

Based on the results from site specific study indicating the low altitude at which long-tailed duck fly and evidence from other offshore wind farms it is predicted that there is a very low risk of collision and that the potential effect from collision is long-term and of negligible magnitude and significance.

Barrier effect

Studies undertaken in Denmark (Kahlert *et al*. 2004) have indicated that there is the potential for a barrier effect, with long-tailed duck changing flight directions at least 1 km from offshore wind turbines and flying around them. Therefore, it is predicted that the proposed development may cause a barrier effect to long-tailed duck in Aberdeen Bay. However studies undertaken in Sweden observed long-tailed ducks flying between wind turbines (Pettersson 2006).

Site specific data obtained from nearly two years of vantage point surveys plus additional observations from radar studies and boat-based surveys did not detect regular daily flights by long-tailed duck across the proposed development area and so a barrier effect that may cause a long-term increase in daily energetic costs is not predicted. There is the potential for a relatively small *ad hoc* increase as birds move around the bay.

Should a barrier effect occur, then birds may fly an additional 3.2 km around the turbines and this may have an incremental increase in daily energetic costs. It is not known where long-tailed duck flying in the proposed development area are flying to or from and therefore it is not possible to assess what level of significance this may have on an individual's energetic fitness. However, based on site specific studies and other surveys (e.g. NESBR, Dean et al. 2004, Söhle et al. 2006) highest numbers of long-tailed duck occur near the Bridge of Don and Cruden Bay. Results from site specific surveys did not record any regular movements of long-tailed duck between the two sites which are approximately 27 km apart nor have there been any reported in published literature (e.g. NESBR). However, should they do so and they fly around the proposed EOWDC then the additional distance flown around the turbines may add 12% to the to the total journey distance. The nearest SPA for this species is Firth, Tay and Eden Estuary SPA, which is approximately 96 km to the south. Should birds from Cruden Bay fly to the Forth Tay and Eden Estuary and consequently fly around the proposed EOWDC then the distance they will travel will increase by approximately 3%. Whether this has a detrimental effect on the individual long-tailed duck depends on its fitness and, if it does, the frequency that it undertakes the journey. However, the numbers of long-tailed duck present in Aberdeen Bay are relatively low and it is not an important area for this species in national or international terms. The increase in flying distance of 3.2 km is unlikely to be significant for a species that migrates from its northerly breeding grounds thought to be in Fennoscandia and North-west Russia, which lie approximately 1,500 km or more from Aberdeen (Wernham et al. 2002). Consequently the species is adapted for long distance movements and if a barrier effect occurs, it is predicted that the impacts will be temporally long-term and of negligible and significance and there will be no adverse effect or significant environmental effect on the population as a whole.

Displacement

Very few long-tailed duck were recorded from any surveys and very small numbers were recorded within the footprint of the proposed EOWDC (Appendix B). Any displacement, should it occur, will impact on a relatively low number of birds and any that are displaced will be able to re-locate if needed to alternative areas as birds occur elsewhere in Aberdeen Bay. Data from aerial surveys identify Cruden Bay to the North and Bridge of Don to the south of the proposed development as being the main areas for long-tailed duck (Söhle *et al*. 2006) both of which are beyond the predicted range of potential displacement and therefore the relatively few long-tailed duck that may be displaced may be able to relocate to areas that, based on the numbers present, are preferred.

Based on the low numbers of long-tailed duck recorded in the vicinity of the proposed development and that alternative areas of Aberdeen Bay are known to be suitable for long-tailed duck it is predicted that the potential impact from displacement is temporally long-term and of negligible magnitude and of minor significance.

Disturbance

Long-tailed ducks may be disturbed by vessels both during the construction phase and during operations from maintenance vessels. Studies have indicated that there may be displacement from service vessels (Pettersson 2006).

During construction there may be a number of vessels operating within the area but these will likely be focussed around a single point where the turbine is being installed. The numbers of long-tailed duck present in the vicinity of the proposed development are relatively low. Evidence from existing wind farms indicates that long-tailed duck may fly up to 2 km from the vessel once disturbed and return once the vessel departs (Pettersson 2006).

It is predicted that between one and four vessels per day may be operating to and from the proposed EOWDC. The presence of the proposed development in the vicinity of the intensively used Aberdeen Harbour means that the potential increase of in vessel movement associated with the proposed EOWDC on a regular basis will not make any noticeable difference to the number of vessels already using Aberdeen Bay. Any specific displacement caused by the service boats will be temporary as long-tailed duck will be able to move back into the area once the vessels leave.

Proposed mitigation will include the development and implementation of a plan that will manage vessel movements to and from the proposed EOWDC. By doing so, the potential and scale of disturbance on long-tailed duck will be minimised.

It is concluded that the effect of disturbance from construction or service boats is temporally short-term of negligible magnitude and of minor significance.

Cumulative and in-combination

The potential future Ocean Laboratory will require additional vessel movements within the proposed development area. Should this occur then there is the potential for a cumulative effect on long-tailed duck. It is not yet known what type of structure the Ocean Laboratory may be, how it will be installed or the number of vessel movements will be required. However, it is likely to be a single structure and it is predicted that the level of disturbance arising from the installation of it will be no greater than that arising from the installation of a single wind turbine. The scale of disturbance is therefore predicted to be localised and of short duration.

Aside from the historical and on-going levels of shipping, there are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts. Based on the numbers present and the low risk of any adverse effect from the proposed development will be negligible and of minor significance.

Table 4-19: Summary of the significance of potential impacts on long-tailed duck.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Very High	Negligible	Medium	Minor
Operation	Collision	Medium	Negligible	Long-term	Negligible
	Displacement	Very High	Negligible	Long-term	Minor
	Barrier	High	Negligible	Long-term	Negligible
Decommissioning	Displacement	Very High	Negligible	Medium	Minor
Cumulative	All	Very High	Negligible	Long-term	Minor

4.10.5 Conclusions

Habitats Appraisal

Based on the evidence from existing offshore wind farms indicating both a very low collision risk, little displacement and that there are not expected to be any significant barrier effects there will not be any adverse effects on the SPAs for which long-tailed duck is a qualifying species.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental effect arising from the proposed development on long-tailed duck.

4.11 Common scoter (*Melanitta nigra*)

4.11.1 Protection and Conservation Status

Common scoter is listed in Schedule I of the Wildlife and Countryside Act, Appendix II of the Bonn Convention Appendix III of the Bern Convention and is on the Red List of Species of Conservation Concern for a breeding species and Amber List for wintering species.

4.11.2 Background

Common scoter		
GB Population	Breeding: 9 – 52 pairs. Winter: 50 – 65,000 ind.	Holling 2010 Cranswick 2001
Scottish Population	Breeding: 9 – 52 pairs. Winter: 25,000 – 30,000 ind.	Holling 2010 Forrester *et al.* 2007
International threshold	16,000 ind.	Calbrade *et al*. 2010
GB threshold	1,000 ind.	Holt *et al*. 2011
Designated east coast sites where species is a noted feature	Firth of Forth Firth of Tay and Eden Estuary	SNH 2011b
European population estimate	Breeding: 100,000 – 130,000 pairs. Wintering: 610,000 individuals.	Birdlife 2004
European population trend	Status 'secure' Trend 'small decline'	Birdlife 2004
World population	2,100,000 – 2,400,000 'adults'	Birdlife 2011

Common scoters breed across the boreal and subarctic zones of Eurasia and have a European breeding population of up to 130,000 pairs.

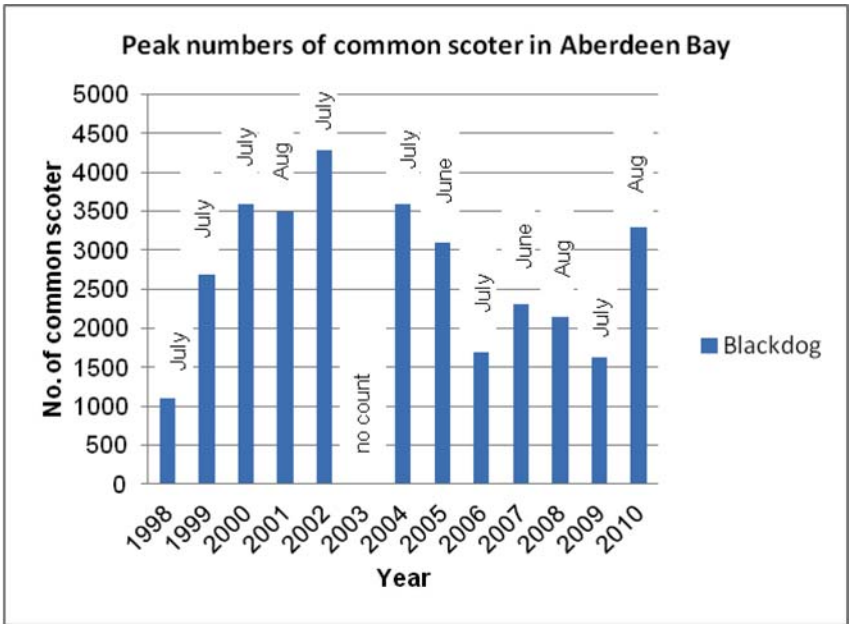
There is a small breeding population in the UK with between 9 and 52 pairs breeding in Scotland (Holling 2010).

Common scoter is a common winter visitor occurring in waters predominantly less than 20 m deep where they forage on benthic mussels and crustaceans. They are generally gregarious and form large flocks in suitable areas (Kaiser *et al.* 2006). In eastern Scotland the main wintering areas are the Moray Firth, Firth of Forth, St Andrews Bay, Carnoustie, Lunan Bay and Aberdeen Bay where a combined total of c.9,000 individuals winter (based on 5 year peak mean counts)(Calbrade *et al.* 2010).

Common scoters also occur during the summer months at regular 'moult' sites where flocks of up to 3,000 individuals may occur (Cork Ecology 2004a). The main summering sites are Aberdeen Bay, Firth of Forth, St Andrew's Bay, St Cyrus and Lunan Bay where a combined total across all sites of c.6,500 birds may summer (Cork Ecology 2004a).

In North-east Scotland common scoter occur regularly in large numbers in a few preferred areas; particularly Aberdeen Bay. Numbers are lowest during the winter months when there are usually less than 200 birds present (Wilson *et al*. 2006). During the summer months a 'moult' flock of common scoter is present in Aberdeen Bay, primarily between the Donmouth and Balmedie to the south and west of the proposed development, with peak counts of up to 4,750 birds occurring (Buckland, Bell and Picozzi 1990; NESBR) (Figure 4-14). However, recent peak counts reported in North-east Scotland Bird Reports indicate that the numbers of common scoter using the bay have steadily decreased in recent years (NESBR).

Common scoters were recorded passing Peterhead throughout the year with a strong seasonal variation. Numbers passing Peterhead were generally low during the winter months with less than four birds per hour. There is a peak spring passage during April when up to 13 birds per hour were recorded with a decrease thereafter. Most sightings were of birds between 300 to 500 metres from shore but some were out to 3 km (Innes 1996).



(Source NESBR; RSPB 2011)

Figure 4-14: Peak numbers of common scoter recorded at Blackdog between 1998 and 2010.

Boat-based surveys

Common scoters were recorded in coastal waters of Aberdeen Bay throughout the year with peak counts in May and July (Figure 4-15).

Figure 4-15 All records were of birds in water depths of less than 20 m with the majority of sightings within 2 km of the coast and in water depths of less than 10 m. There were relatively few records of common scoter within the proposed development area with small numbers present during the spring and autumn migration periods. The largest flocks were recorded between Donmouth and Balmedie with a cluster of flocks totalling 1,200 common scoters in July 2007 (Appendix B) (IECS 2008).

Surveys undertaken between August 2010 and August 2011 recorded relatively low numbers of common scoter within the proposed development area. Peak totals occurred in September and January when approximately 100 birds were present (SMRU 2011b; 2011c).

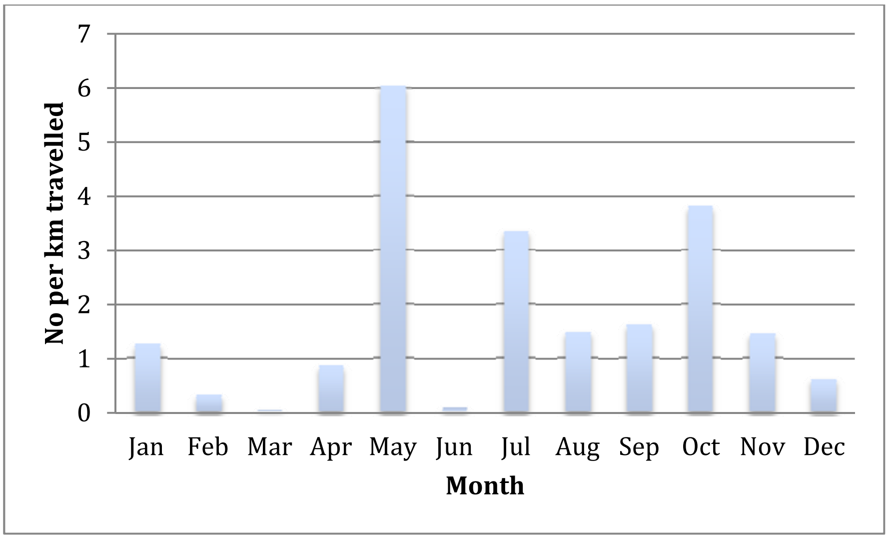


Figure 4-15: Encounter rates of common scoter in Aberdeen Bay from all boat-based surveys (birds/km travelled).

Most sightings from boat-based surveys were of birds when not on transect and outwith the 300 m transect width. Consequently, the number of birds recorded for population estimates were relatively low. Greatest numbers of common scoter were recorded within the wider proposed EOWDC development area but not within the footprint of the proposed development; with seasonal estimates using *Distance* sampling indicating peak numbers in the proposed EOWDC development area of 1,157 individuals in the spring and 442 individuals in the summer period (Table 4-20,Figure 4-16 Figure 4-17).

Table 4-20: Seasonal estimates of density and abundance of Common Scoters in the proposed EOWDC and 'control' Areas in 2007/08.

	Density Estimate (km^2)	S.E	Estimated Abundance	S.E.	Number of Observations
EOWDC - Winter	0.23	0.15	12	7.7	4
Control - Winter	0.09	0.09	5	4.6	2
EOWDC - Spring	23.1	45.48	1,157	2,310	4
Control - Spring	0.39	0.11	20	5.9	5
EOWDC - Summer	8.69	18.62	442	946	5
Control - Summer	1.55	1.58	79	80	1
EOWDC - Autumn	0.02	0.02	1	1.4	1
Control - Autumn	0.10	0.08	5	4.2	4

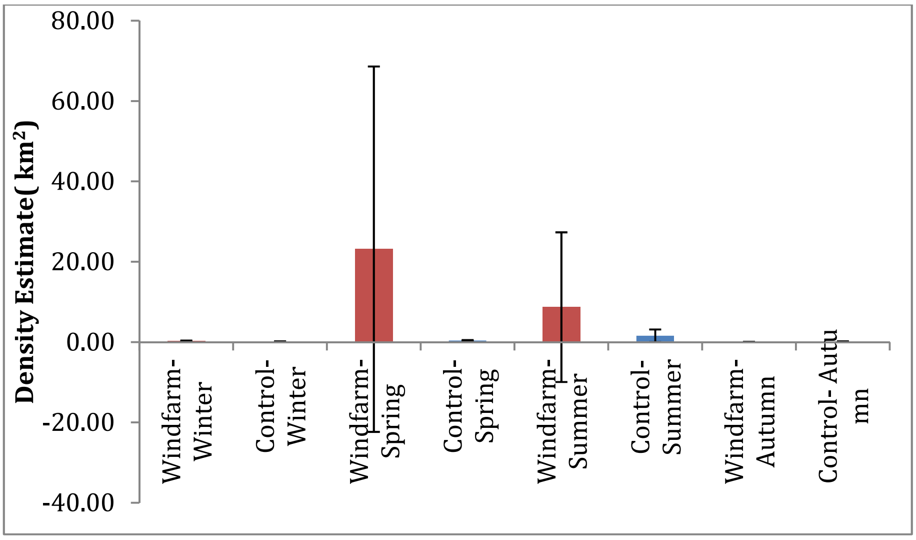


Figure 4-16: Seasonal estimates (+/- SE) of density of Common Scoters in the proposed EOWDC and 'control' Areas – 2007/08.

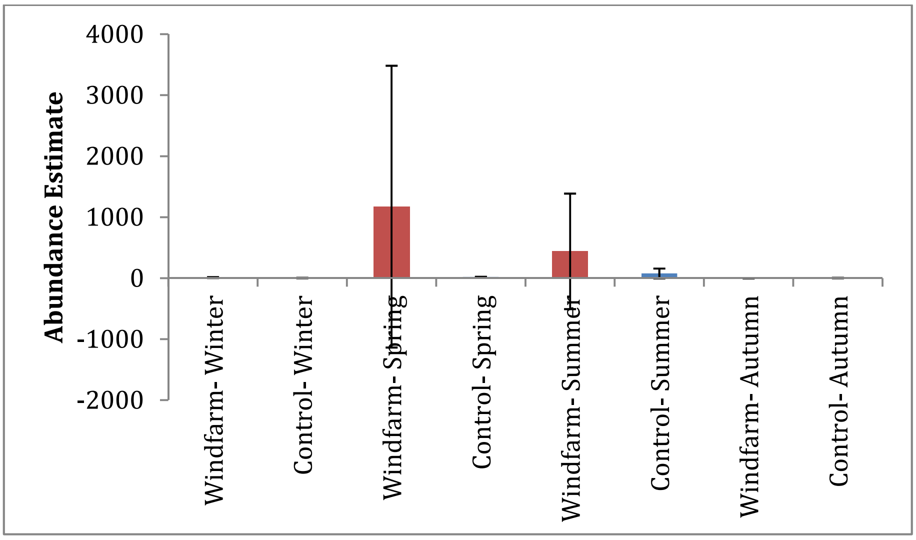


Figure 4-17: Seasonal estimates (+/- SE) of abundance of Common Scoters in the proposed EOWDC and 'control' Areas – 2007/08.

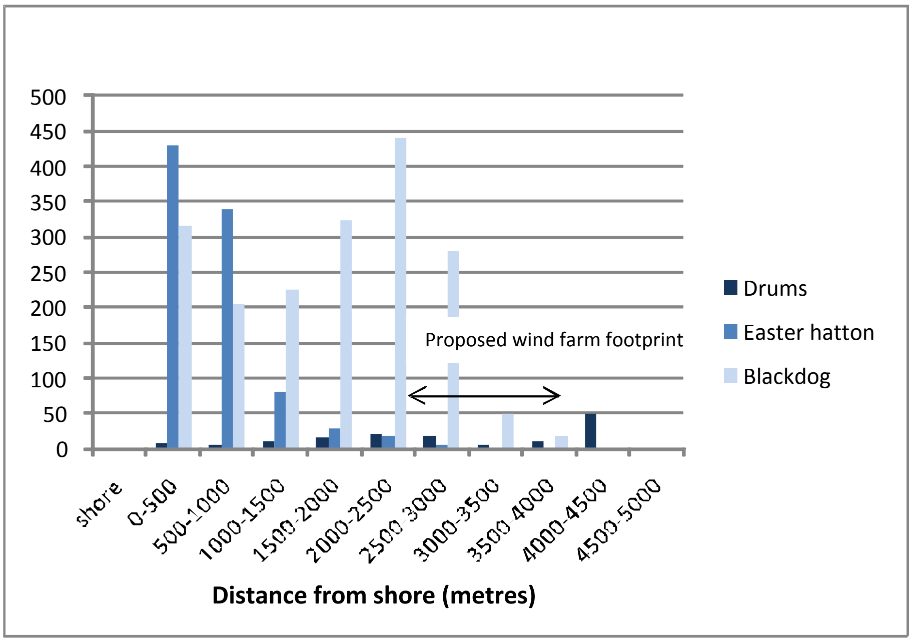
Vantage Point surveys

Results from monthly Vantage Point counts undertaken in Aberdeen Bay throughout the year recorded relatively low numbers of common scoter between December and February with numbers increasing from March onwards and peak movements between June and September when up to nearly 200 birds per hour were recorded passing in July 2007 (Alba Ecology 2008a,b). This is in contrast to the records from Peterhead where most sightings occurred during the spring and there were relatively few sightings during the summer. Birds were recorded at all vantage point sites with peak numbers at Balmedie during June 2007. Of those for which flight heights were recorded at least 95% were flying below 30 m with the majority of those recorded at greater than 30 m being at Donmouth. Most records were within 1 km and 2 km from shore, with relatively few between 2 - 3 km.

Bird Detection Radar

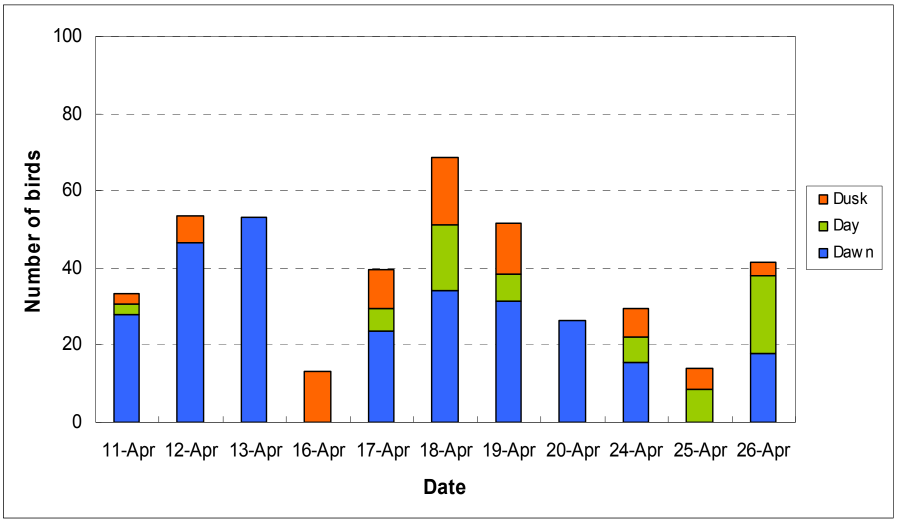
Common scoter were frequently observed during the radar studies undertaken during October 2005 with a total of 1,054 sightings of which 911 were at Easter Hatton and 143 at Drums. Common scoters recorded at Easter Hatton were generally less than 2 km from shore with those at Drums between 4 km and 4.5 km from shore. Of those recorded in flight all were flying below 5 m. (Walls *et al.* 2006).

A seventeen day radar study was undertaken at Blackdog between 11 and 26 of April 2007. During this survey a total of 1,872 common scoters were recorded in relatively small flocks of no more than 60 birds (Simms *et al.* 2007). Unlike the surveys undertaken in October 2005, approximately 50% of all common scoter were between 2 km and 4 km from shore (Figure 4-18). Although April is a period of spring migration for common scoter, there was no clear difference between the numbers of birds heading north as opposed to flying south, which indicates that the movements of birds during this period may have related to foraging movements as opposed to migrating individuals. As the majority of sightings were during the first two hours of dawn the movements recorded may also relate to birds redistributing after night time drifting (Figure 4-19).



(Adapted from Walls *et al* 2006, Simms *et al* 2007)

Figure 4-18: Distance from shore for common scoter from three locations in Aberdeen Bay during surveys undertaken in October (Drums and Hatton) and April (Blackdog).



(Source Simms *et al.* 2007)

Figure 4-19: The diurnal flight behaviour of common scoter at Blackdog.

4.11.3 Summary of Results

Common scoters were frequently recorded throughout the year during surveys undertaken across Aberdeen Bay. Peak numbers recorded during boat-based surveys were during the spring and summer months with most records from within the proposed EOWDC survey area. Land based surveys recorded peak numbers of common scoter during the summer months with most birds being recorded off Blackdog. Most common scoter were recorded within 2 km of the coast and in waters of less than 10 m. However, a survey undertaken in April recorded the majority of common scoter off Blackdog as being between 1 km and 3 km from shore.

Peak counts of common scoter recorded within Aberdeen Bay are of national importance but are not of international importance.

4.11.4 Species Sensitivities

Qualifying species

There are two SPAs in the region for which common scoter is a qualifying species as part of waterfowl assemblages: Firth of Forth SPA and Firth of Tay and Eden Estuary SPA.

Flight height

Flight heights obtained from boat-based surveys undertaken in Aberdeen Bay recorded 77 common scoters in flight of which 2.5% were recorded as flying above 25 m and therefore at potential risk of collision.

Extensive studies undertaken, particularly in the East Irish Sea have recorded large numbers (n=30,847) of common scoter. Modelling results based on a minimum rotor blade height of 20 m predict 4.0% of flights at rotor height and calculate the mean flight height as 9.3 m (Cook *et al*. 2012).

Collision risk

Site specific monitoring using boat-based and land-based surveys and other data sources indicate that common scoter are widespread and frequent within Aberdeen Bay and occur in large flocks of up to a few thousand birds in certain areas. They occur widely with the majority of sightings occurring in nearshore waters within 3 km of the shore and in water depths of <20 m.

In order to determine potential effects of collision on common scoter a collision risk assessment has been undertaken (Appendix A1).

The CRM predicts between 0 and 1 common scoter may collide with the proposed development depending on the avoidance rate selected and use of site specific or generic modelled data (Table 4-21).

Table 4-21: Common scoter predicted collision mortalities per year.

Rochdale	Flight height data source	Avoidance rate (%)			
		95.0	98.0	99.0	99.5
Original	EOWDC	0 +/- 0.04	0 +/- 0.01	0 +/- 0.01	0 +/- 0.00
	Generic	1 +/- 0.63	0 +/- 0.25	0 +/- 0.13	0 +/- 0.06
Revised	EOWDC	0 +/- 0.03	0 +/- 0.01	0 +/- 0.01	0 +/- 0.00
	Generic	0 +/- 0.58	0 +/- 0.23	0 +/- 0.12	0 +/- 0.06

Based on the precautionary avoidance rate of 98% it is predicted that there will be less than one collision per year.

Based on the results from collision risk modelling, which predicts a total of less than one collision per year there will not be a significant impact on the common scoter due to collisions.

The Firth of Forth SPA is approximately 134 km away and has a five year peak mean population of 1,070 individuals. The potential increase in mortality of less than one bird per year will not cause an adverse effect on the population.

The Firth of Tay and Eden Estuary SPA lies approximately 96 km away from the proposed development and has a five year peak mean population of 1,037 scoters. The potential increase in mortality of less than one bird per year will not cause an adverse effect on the population.

No collisions have been reported from post-construction monitoring studies undertaken in Denmark and Sweden indicating that common scoter have a very high avoidance rate and that the majority of birds will detour around the proposed development (Petersen *et al*. 2006; Pettersson 2005).

Based on the results the very low risk of collision and results from operating wind farms that have demonstrated significant avoidance rates by common scoter it is concluded that the potential effect from collision risk is temporally long-term and of negligible magnitude and significance.

Barrier effect

Studies undertaken in Sweden and Denmark have shown that there is the potential for a barrier effect on common scoter with changes in flight directions avoiding wind turbines from up to 1 km away (Christensen and Hounisen 2004; 2005). Therefore, it is predicted that the proposed development may cause a barrier effect to common scoter in Aberdeen Bay.

Site specific studies undertaken from vantage points or boats did not record regular daily movements of common scoter within Aberdeen Bay to and from feeding or roosting areas. Nor have there been any reports of regular daily movements in published literature (e.g. NESBR; Buckland, Bell and Picozzi 1990). However, most flight activity at Blackdog was recorded at dawn and these may be birds moving from a roost site to feeding areas (Figure 4-19).

Should a barrier effect occur with common scoter making daily movements from one location to another around the proposed development area then they may incur an additional flight distance of up 3.2 km each way, or a total of 6.4 km. This may increase the daily energy expenditure to between 2.2% and 2.6% (Speakman, Gray and Furness 2009). This is a relatively small increase in daily energy expenditure and is unlikely to have an adverse effect on common scoter in Aberdeen Bay. Although the potential effect of increased energy expenditure depends on individual fitness.

As with eider, the peak numbers of common scoter in Aberdeen Bay occur during July and August when the adults undergo a complete wing moult over a period of four weeks, during which time they become flightless. The daily energetic costs during this period may increase but the birds remain within certain areas where they can forage and are unable to undergo daily flight movements. Consequently, there is no incremental increase in daily energy expenditure due to the barrier effect during this period of potentially higher energy expenditure.

Data obtained from nearly two years of vantage point surveys did not detect any regular daily flights by common scoter across Aberdeen Bay, although the increased frequency in flights at dawn indicates that these may occur. Should they do so then there may be a relatively small increase in energetic expenditure.

The incremental increase in the distance migrating common scoter fly from their breeding grounds in Scandinavia or Russia should they be displaced during their migration to or from the Firth of Forth or Firth Tay and Eden Estuary SPAs will be temporally long-term and of negligible magnitude and significance and will not cause an adverse effect.

Displacement

Peak common scoter density within the surveyed area that includes the proposed EOWDC site was 23.1 birds/km^2 during the breeding season. Based on the peak densities recorded in Year 1, should there be a total displacement of common scoter from within the proposed development area then it is predicted that up to 99 common scoter may be displaced from the proposed development area during periods of peak density.

A range of potential displacement impacts have been assessed based on between 0% and 100% displacement and 0% and 100% mortality within the proposed development only and out to 2 km.

Common scoters were considered to be at moderate risk of displacement in the review undertaken by Langston on the potential impacts of wind farms (Langston 2010). Based on this review a moderate displacement of between 40% and 60% of common scoter has been considered for this assessment (Table 4-22).

Based on the assumptions made that there may be up to 50% displacement then between 5 and 50 common scoter may be impacted due to displacement from with the proposed development area alone.

Based on the assumptions made that there may be up to 50% displacement then between 10 and 422 common scoter may be impacted due to displacement should displacement occur out to 2 km.

The peak reported count of common scoter in Aberdeen Bay is 4,300 common scoter (Figure 4-14). Therefore, potentially up to 10% of the common scoter within Aberdeen Bay may be displaced and consequently of medium magnitude. However, the distribution of common scoter within Aberdeen Bay is clustered with peak numbers occurring at various sites across the bay during different seasons (Söhle *et al*. 2006).

The area off Blackdog regularly records the peak counts of common scoter in Aberdeen Bay (NESBR) and should displacement occur, a greater proportion of common scoter may be affected than is estimated using densities obtained from boat-based surveys alone.

Data from onshore counts, published in North-east Scotland Bird reports, indicate that numbers of common scoter in Aberdeen Bay may, during peak periods of July and August, be higher than has been recorded from the boat-based surveys. Recent peak counts of 3,300 common scoter have been reported in August 2010 (Figure 4-14). The total area of Aberdeen Bay from Collieston to Aberdeen and out to 4 km is approximately 95 km^2 and therefore a peak density of 34.7 common scoter/km^2 may occur across the bay during peak periods.

Based on densities of common scoter derived from land based observations and published in the North-east Scotland Bird Report and assuming that up to 50% of common scoter may be displaced, then between 0 and 67 common scoter may be impacted from proposed development area and between 0 and 691 individuals, if displacement occurs out to 2 km (Table 4-22).

Densities of common scoter will vary considerably depending on the location of the Scoter flocks. Data from boat-based surveys indicate that the scoter flocks remain inshore of the proposed development and do not use the proposed EOWDC development area.

Post-construction monitoring undertaken at Horns Rev offshore wind farm has indicated that displacement of common scoter may not occur and that common scoter occur within an operating wind farm with a similar frequency as outwith (Petersen and Fox 2007).

Common scoter distribution is closely related to water depth and prey availability, particularly bivalves (COWRIE 2003; Kaiser *et al*. 2006). Evidence from constructed wind farms indicates that there is likely to be an increase in mussels around the base of turbines and that no significant negative impacts have been detected on mussels from the construction of wind farms (e.g. Maar *et al.* 2009). No difference in the recruitment of bivalves has been found in constructed offshore wind farms (Bergman *et al*. 2010). Consequently, there is unlikely to be a negative impact on prey availability for common scoter within Aberdeen Bay.

Based on evidence from existing offshore wind farms it is predicted that little or no displacement of common scoter will occur and the potential impact from displacement is of low magnitude, temporally long-term and of minor significance.

Table 4-22: Potential number of common scoter displaced by the proposed development based on boat-based data and land-based observations.

% Impacted	Displacement (development area) Boat-based data			Displacement (development area + 2 km buffer) Boat-based data			Displacement (development area) NESBR data			Displacement (development area + 2 km buffer) NESBR data		
	40%	50%	60%	40%	50%	60%	40%	50%	60%	40%	50%	60%
0%	0	0	0	0	0	0	0	0	0	0	0	0
10%	3.96	4.95	5.94	33.8	42.25	50.7	59.6	74.5	89.4	512	640	768
20%	7.92	9.9	11.88	67.6	84.5	101.4	5.96	7.45	8.94	51.2	64	76.8
30%	11.88	14.85	17.82	101.4	126.75	152.1	11.92	14.9	17.88	102.4	128	153.6
40%	15.84	19.8	23.76	135.2	169	202.8	17.88	22.35	26.82	153.6	192	230.4
50%	19.8	24.75	29.7	169	211.25	253.5	23.84	29.8	35.76	204.8	256	307.2
60%	23.76	29.7	35.64	202.8	253.5	304.2	29.8	37.25	44.7	256	320	384
70%	27.72	34.65	41.58	236.6	295.75	354.9	35.76	44.7	53.64	307.2	384	460.8
80%	31.68	39.6	47.52	270.4	338	405.6	41.72	52.15	62.58	358.4	448	537.6
90%	35.64	44.55	53.46	304.2	380.25	456.3	47.68	59.6	71.52	409.6	512	614.4
100%	39.6	49.5	59.4	338	422.5	507	53.64	67.05	80.46	460.8	576	691.2

Disturbance

Common scoter may be disturbed by vessels, both during the construction phase and during operations from maintenance vessels. Studies have indicated that there may be displacement from large vessels out to 1,000 m (Larsen and Laubek 2005).

During construction there may be a number of vessels operating within the area but these will likely be focussed around a single point where the turbine is being installed. Consequently, common scoter may be displaced from within 1 km radius of the installation; an area of 3 km^2. Based on the highest recorded density of 23.1 birds/km^2, it is predicted that up to 69 common scoter may be displaced from the vicinity during the construction period. This equates to approximately 1.5% of the peak common scoter population within Aberdeen Bay based on the peak estimated figure of 4,300 individuals. Using data from NESBR and a density of 34.7 birds/km^2 it is predicted that 104 common scoter may be displaced by vessels. However, the densities of common scoter across the bay will vary considerably and the numbers displaced may be higher or lower than this depending on the location of the scoter flocks in relation to the vessels.

The construction period will be of medium duration and the displacement impacts from construction vessels temporary. Consequently, any potential impact is predicted to be negligible.

Displacement by service boats may reduce the re-population potential of the proposed development area. It is not known exactly how many service vessels may be required but is predicted to be no more than four vessels at the site on any one occasion. The presence of the proposed development in the vicinity of the intensively used Aberdeen Harbour means that the potential increase by vessel movement will not have any noticeable difference to the number of vessels already using Aberdeen Bay. Any specific displacement caused by the service or construction boats will be of low magnitude and temporary as common scoter will be able to move into the area once the vessels leave.

Proposed mitigation will include the development and implementation of a plan that will manage vessel movements to and from the proposed EOWDC. By doing so, the potential and scale of disturbance on Scoter and other seabirds and wildfowl will be minimised.

Based on the relatively low numbers of common scoter predicted to be impacted and the medium duration from construction along with the small incremental increase in vessel movements already being undertaken in Aberdeen Bay, it is concluded that the effect of disturbance from construction or service boats is short-term or long-term and of low magnitude and minor significance.

Cumulative and in-combination

The potential future Ocean Laboratory will require additional vessel movements within the proposed development area during the installation and maintenance of it. Should this occur then there is the potential for a cumulative effect to common scoter. It is not yet known what type of structure the Ocean Laboratory may be, how it will be installed or the number of vessel movements will be required. However, it is a single structure and it is predicted that the level of disturbance will be no greater than that arising from the installation of a single wind turbine. The scale of disturbance is therefore predicted to be localised and of medium duration.

Aside from the historical and on-going levels of shipping, there are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts. There is not predicted to be any cumulative or in-combination impacts arising at other planned developments as their locations offshore and their water depths indicate that common scoter may not regularly occur in these areas. Studies undertaken at the Beatrice demonstrator wind farm have only recorded one flock of 13 common scoter (Talisman 2005). Consequently, there are unlikely to be any cumulative or in-combination impacts. Any impacts, should they occur, will be of negligible magnitude and minor significance.

Table 4-23: Summary of the significance of potential impacts on common scoter.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Very High	Low	Medium	Minor
Operation	Collision	Medium	Negligible	Long-term	Negligible
	Displacement	Very High	Medium	Long-term	Minor
	Barrier	High	Negligible	Long-term	Negligible
Decommissioning	Displacement	Very High	Low	Medium	Minor
Cumulative	All	Very High	Negligible	Long-term	Minor

4.11.5 Conclusions

Habitats Appraisal

Based on site specific data and evidence from existing offshore wind farms indicating both a very low collision risk and little, if any, displacement and that there are not expected to be any significant barrier effects. There will not be any adverse effects on the SPAs for which common scoter is a qualifying species.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental effect arising from the proposed development on common scoter, although there is potential for an effect of minor significance to arise from displacement effects should they occur.

4.12 Velvet scoter (*Melanitta fusca*)

4.12.1 Protection and Conservation Status

Velvet scoter is listed in Appendix II of the Bonn Convention, Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

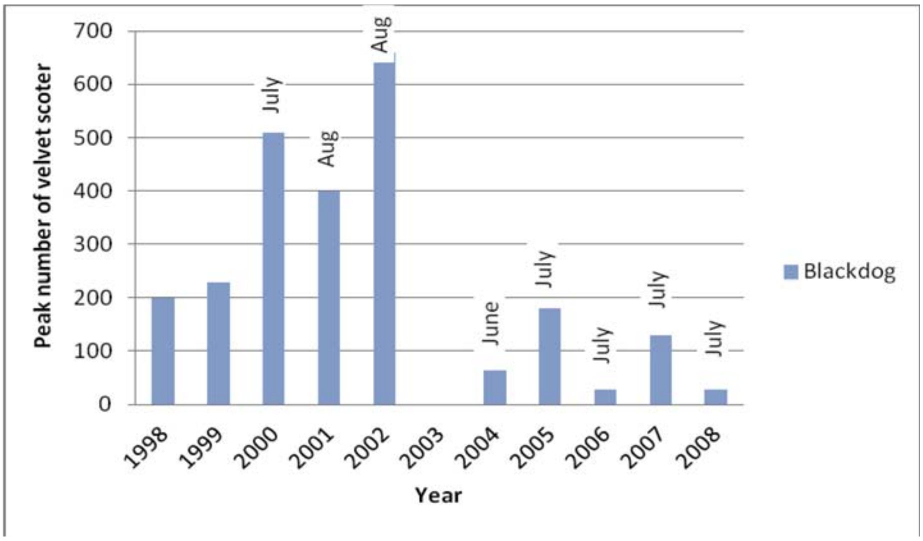
4.12.2 Background

Velvet scoter		
GB Population	Winter – 3,000 ind.	BTO 2011
Scottish Population	Winter – 2,500 – 3,500	Forrester *et al*. 2007
International threshold	10,000 ind.	Calbrade *et al.* 2010
GB threshold	25 ind.	Holt *et al.* 2011
Designated east coast sites where species is a noted feature	Firth of Forth Firth of Tay and Eden Estuary	SNH 2011b
European population estimate	Breeding 85,000 – 100,000 pairs Wintering – >140,000 individuals	Birdlife 2004
European population trend	Status 'declining' Trend 'moderate decline'	Birdlife 2004
World population	1,700,000 – 3,000,000	Birdlife 2011

Velvet scoters do not breed in the UK but are a regular winter visitor with an estimated wintering population of approximately 3,000 individuals along the east coast of the UK (Wernham *et al*. 2002). The main areas for velvet scoter along the east coast of Scotland are the Moray Firth, St Andrew's Bay and the Firth of Forth with a total of about 2,000 birds wintering (Calbrade *et al.* 2010).

During the late summer, small numbers of velvet scoter occur amongst the larger flocks of moulting common scoter and numbers increase for the rest of the year with peak wintering numbers in February.

During the winter month's velvet scoter are uncommon in North-east Scotland with ones and twos being reported around the coasts. Peak numbers occur during July and August when velvet scoters occur amongst the moulting common scoter flock in Aberdeen Bay. Peak numbers vary considerably across years but up to 600 individuals have been recorded (Buckland, Bell and Picozzi 1990; NESBR) (Figure 4-20). Offshore surveys undertaken in Aberdeen Bay have reported 89 velvet scoter in 2005/2006 and 28 in 2006/2007 (Holt *et al*. 2011).



(Source NESBR)

Figure 4-20: peak numbers of velvet scoter recorded at Blackdog between 1998 and 2008.

Passage of velvet scoter past Peterhead occurs during spring and autumn with peak counts of up to 300 birds occurring in October and evidence of a small spring passage when up to 150 birds were recorded during April (Innes 1996).

Boat-based surveys

Three sightings of velvet scoter were made from boat-based surveys totalling 14 birds. Two singles in February, a flock of five in July and seven in October (IECS 2008). There were no sightings of velvet scoter from Year 2 boat-based surveys.

Vantage Point surveys

In Aberdeen Bay low numbers of velvet scoter were recorded during the winter months with an increase in numbers during the year and a peak passage of velvet scoter of usually less than one bird per hour during June. Results from all the vantage point counts undertaken recorded only two velvet scoter flying above 30 m. Most birds were recorded between 1 km and 3 km from shore (EnviroCentre 2007; Alba Ecology 2008b).

Bird Detection Radar

A total of 28 velvet scoter were recorded during radar surveys in October 2005. Numbers were split fairly evenly between the two sites at which surveys were undertaken with 13 at Drums and 15 at Easter Hatton. All sightings were within 2.5 km from shore and all birds recorded in flight were flying below 10 m (Walls *et al* 2005).

Six velvet scoter were recorded at Blackdog within 1 km of the coast between 11 and 26 April 2007 (Simms *et al.* 2007).

4.12.3 Summary of Results

Velvet scoter were only occasionally recorded throughout the year during surveys undertaken across Aberdeen Bay. A total of fourteen velvet scoter were recorded from boat-based surveys and a peak from shore-based counts occurred in June. Most velvet scoter were recorded between 1 km and 3 km off the coast. Of those recorded in flight all but one were recorded flying below 30 m.

Although no counts during surveys undertaken across Aberdeen Bay were of national importance peak counts from Blackdog have, in the past, been of national importance.

4.12.4 Species Sensitivities

Qualifying species

There are two SPAs in the region for which velvet scoter is a qualifying species as part of waterfowl assemblages: Firth of Forth SPA and Firth of Tay and Eden Estuary SPA.

Flight height

There were 12 records of velvet scoter in flight from which flight heights were obtained. All sightings were of birds flying below 25 m.

Elsewhere in the UK small numbers (<20) of velvet scoter have been recorded all of which have been flying below rotor height with a mean flight height of less than 1 m (Cook *et al*. 2012.).

Collision risk

Site specific surveys using boat-based and land-based surveys and other data sources (e.g. NESBR; Buckland, Bell and Picozzi 1990), indicate that velvet scoters are generally uncommon in Aberdeen Bay, occurring within the larger common scoter flocks. They occur mainly within 3 km of the coast and in waters less than 20 metres.

Evidence from elsewhere indicates that velvet scoter detour around wind farms and are at low risk of collision. A total of nearly 1,600 velvet scoters were recorded in the Kalmar Sound and no collisions were recorded (Petterrson 2006). Furthermore, all records of velvet scoter in Aberdeen Bay were of birds flying below 25 metres and therefore below turbine height.

Consequently, the risk of an impact arising due to collisions is low and significance should it occur negligible.

The two SPAs in the region for which velvet scoter is a qualifying species as part of an assemblage are both over 90 km away. The probability of birds from these SPA populations flying through the proposed development area at turbine height is low and consequently the risk of collision is also very low. Based on the above it is concluded that the impact will be long-term and of negligible magnitude and significance and there will not be an adverse effect on the population of velvet scoter within Aberdeen Bay due to collision.

Barrier effect

Studies undertaken in Sweden have shown that there is the potential for a barrier effect on velvet scoter with changes in flight directions of up to 1 km from offshore wind turbines and birds seen flying around wind farms (Petterrson 2006). Therefore, it is predicted that the proposed development may cause a barrier effect to common scoter in Aberdeen Bay.

No regular daily movements of velvet scoter have been recorded within Aberdeen Bay to and from feeding or roosting areas. However, velvet scoters frequently mix in flocks of common scoter and should a barrier effect occur for common scoter then it may also do so for velvet scoter.

As with common scoter, the potential additional increase in daily energy expenditure due to possible displacement may be between 2.2% and 2.6% (Speakman, Gray and Furness 2009).

This is a relatively small increase in daily energy expenditure and is unlikely to have an adverse effect or significant impact on velvet scoter in Aberdeen Bay. However, the effect on any individual depends on its fitness and any increase in energetic expenditure may affect some individuals more than others.

The incremental increase in the distance velvet scoter, migrating from their breeding grounds in Scandinavia or Russia, may incur should they detour during their migration to or from the Firth of Forth or Firth Tay and Eden Estuary SPAs will be long-term of negligible magnitude and significance and not cause an adverse effect.

Displacement

Very few velvet scoter were recorded during site specific surveys undertaken within the bay and peak counts from Blackdog have, in recent years, been below 200 individuals (Figure 4-20). There are no reports on whether velvet scoter are displaced by offshore wind farms but little or no displacement to the closely related common scoter indicate that displacement is unlikely to occur (Petersen and Fox 2007). It is predicted that the impact will be temporally long-term and of low magnitude and minor significance and there will not be an adverse effect or significant impact from the proposed development on velvet scoter.

Disturbance

Disturbance effects on velvet scoter will be similar to those identified for common scoter and they may be disturbed by vessels, both during the construction phase and during operations from maintenance vessels. The numbers of velvet scoter recorded within the proposed development area were very low with a total of fourteen velvet scoter recorded in the total area surveyed from two years of boat-based surveys. Published reports indicate that there can be up to nearly 700 velvet scoter in Aberdeen Bay in peak years (Figure 4-20). Therefore, during certain periods and in certain years the numbers potentially displaced could be greater. Proposed mitigation will include the development and implementation of a plan that will manage vessel movements to and from the proposed EOWDC. By doing so, the potential and scale of disturbance on Scoter and other seabirds and wildfowl will be minimised. It is therefore predicted that disturbance from either construction or service vessels will be temporally long-term and of low magnitude and minor significance and the impact will not cause an adverse effect.

Cumulative and in-combination

Aside from the historical and on-going levels of shipping, there are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on velvet scoter present within Aberdeen Bay. There is not predicted to be any cumulative or in-combination impacts arising at other planned developments as their locations offshore and their water depths indicate that velvet scoter may not regularly occur in these areas. No velvet scoter were reported during studies undertaken at the Beatrice demonstrator wind farm (Talisman 2005). Consequently there are unlikely to be any cumulative or in-combination impacts. Should they occur they will be of neglible magnitude and minor significance.

Table 4-24: Summary of significance of potential impacts on velvet scoter

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Very High	Low	Medium	Minor
Operation	Collision	Medium	Negligible	Long-term	Negligible
	Displacement	Very High	Low	Long-term	Minor
	Barrier	High	Negligible	Long-term	Negligible
Decommissioning	Displacement	Very High	Low	Medium	Minor
Cumulative	All	Very High	Negligible	Long-term	Minor

4.12.5 Conclusions

Habitats Appraisal

Based on the number of velvet scoter recorded and evidence from existing offshore wind farms indicating a very low collision risk, potentially little or no displacement and no significant barrier effects there will not be any adverse effects on the SPAs for which velvet scoter is a qualifying species.

Environmental Impact Assessment

Based on the number of velvet scoter recorded and evidence from existing offshore wind farms it is predicted that there will not be a significant environmental effect arising from the proposed development on velvet scoter.

4.13 Common goldeneye (*Bucephala clangula*)

4.13.1 Protection and Conservation Status

The (Common) goldeneye is listed in Appendix II of the Bonn Convention, Appendix III of the Bern Convention and is on the Green List of Species of Conservation Concern.

4.13.2 Background

Goldeneye		
GB population	Breeding – 200 pairs Winter – 25,000 ind.	BTO 2011
Scottish population	Breeding: 120 - 150 prs. Winter: 10,000 – 12,000 ind.	Holling *et al*. 2010 Forrester *et al.* 2007
International threshold	11,500 ind.	Calbrade *et al*. 2010
GB threshold	200 ind.	Holt *et al*. 2011
Designated east coast sites where species is a noted feature	Firth of Forth: 581 ind. (08/09) Firth of Tay and Eden Estuary: 255 ind.	Calbrade *et al.* 2010 SNH 2011b
European population estimate	Breeding 490 – 590,000 prs. Wintering – >310,000 ind.	Birdlife 2004
European population trend	Status 'secure' Trend 'small increase'	Birdlife 2004
World population	2,5 – 4,600,000 'adults'	Birdlife 2011

Goldeneye breed beside freshwater habitats across northern Europe with a total breeding population of up to 590,000 pairs primarily in Sweden, Finland and Russia. There is a small and localised breeding population in the UK with approximately 120 to 150 pairs nesting in Scotland (Holling *et al.* 2010).

During the winter goldeneye move away from the breeding sites and move onto both fresh and salt water bodies. In eastern Scotland the Firth of Forth holds the largest wintering population in the UK with a peak mean of 735 over the last five years (Holt *et al*. 2011). This is considerably lower than recent historical counts at the site where over 2,000 goldeneye used to be regularly recorded (Cork Ecology 2004a).

In North-east Scotland goldeneye has only recently colonised the region as a scarce breeding bird with a small but increasing population of about 30 nests (Scott 2011), inland. Relatively low numbers of goldeneye winter along the coasts and inland freshwater. The main areas are Loch of Skene and Loch of Strathbeg where peak numbers of up to 100 to 200 birds may occur (Buckland, Bell and Picozzi 1990; NESBR).

On the coast goldeneye are rarely recorded between June and September with birds present from October onwards when numbers passing Peterhead peak with up to 2 birds per hour between November and January (Innes 1996). All sightings of goldeneye at Peterhead were of birds within 1 km of the shore.

Boat-based surveys

Five goldeneye were recorded from boat-based surveys with three in April and two in November.

Vantage Point surveys

Small numbers of goldeneye were recorded passing through Aberdeen Bay with a total of 41 records between November and April over the two years of data collection.

Seven goldeneye were recorded from boat-based surveys with three in April, two in July and two in November.

Bird Detection Radar

No goldeneye were recorded during the studies undertaken at Easter Hatton and Drums during October 2005 but three were recorded at Blackdog during the additional radar surveys undertaken at Blackdog during April 2007 (Simms *et al.* 2007).

4.13.3 Summary of Results

Goldeneye were infrequently recorded in Aberdeen Bay with most sightings from vantage point surveys between November and April 2007 and 2008.

4.13.4 Species Sensitivities

Qualifying species

There are two SPAs for which goldeneye are part of the qualifying assemblages: Firth of Forth SPA and Firth of Tay and Eden Estuary SPA. Goldeneye was also listed as part of the qualifying assemblages in original citation for the Loch of Strathbeg but is not so for subsequently updated ones.

Flight height

Very few records of goldeneye were made from site specific boat-based or land-based surveys and only two records of their flight altitudes made. Both records were of birds flying below 10 m.

Elsewhere, there are very limited data from other offshore wind farms on flight heights for goldeneye.

Collision risk

Results from site specific surveys indicate that goldeneye are scarce in Aberdeen Bay and primarily occur in near-shore waters. Evidence from other offshore wind farms indicated that goldeneye are at low risk of collision from offshore wind farms. A total of nearly 3,100 goldeneye were recorded during studies undertaken in Kalmar Sound and no collisions were recorded (Pettersson 2005). Based on the relatively low numbers of goldeneye recorded and evidence from other wildfowl of a potentially high avoidance rate it is predicted that the risk of an adverse or significant environmental effect on goldeneye from collision mortalities arising from the proposed development is long-term and of negligible magnitude and significance.

Barrier effect

Evidence from studies undertaken at Kalmar Sound suggests that there is the potential for some barrier effects as goldeneye may avoid flying through offshore wind farms (Pettersson 2005). Should a barrier effect occur then goldeneye will fly around the proposed development. This may incur an overall increase in flying distance of approximately 3.2 km. Site specific surveys and published reports have not recorded any regular feeding or roosting flights by goldeneye across Aberdeen Bay nor any regular usage of the site itself (e.g. NESBR).

Goldeneye in Aberdeen Bay are not frequently using the site and are therefore those recorded are likely to be passage or transient birds. Passage goldeneye occurring in Scotland originate from Fennoscandia and migrate at least 750 km, if not further to and from their breeding and wintering grounds. Scottish birds remain mainly in the vicinity of their breeding areas (Wernham *et al* 2002). Consequently, any additional distance flown by goldeneye on passage, should goldeneye fly around the proposed development, will be small compared to the total distance of their migration and will be of negligible magnitude and significance and not cause an adverse effect.

Displacement

Goldeneye do not use Aberdeen Bay for feeding or roosting and therefore no displacement effects will occur. However, should they do so, the impacts will be of negligible magnitude and of minor significance.

Cumulative and in-combination

The low level of usage of the site by goldeneye and the relatively few recorded from other UK developments indicate that there will not be any cumulative or in-combination impacts. Any impacts, should they occur, will be of negligible magnitude and significance

Table 4-25: Summary of significance of potential impacts on goldeneye.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Very High	Negligible	Medium	Minor
Operation	Collision	Medium	Negligible	Long-term	Negligible
	Displacement	Very High	Negligible	Long-term	Minor
	Barrier	High	Negligible	Long-term	Negligible
Decommissioning	Displacement	Very High	Negligible	Medium	Minor
Cumulative	All	High	Negligible	Long-term	Negligible

4.13.5 Conclusions

Habitats Appraisal

There are no SPAs for which goldeneye is a qualifying species that will be adversely affected by the proposed development.

Environmental Impact Assessment

Based on the relatively low numbers of goldeneye recorded and their known behaviour it is predicted that there will not be a significant environmental effect arising from the proposed development on goldeneye.

4.14 Red-breasted merganser (*Mergus serrator*)

4.14.1 Protection and Conservation Status

Red-breasted merganser is listed in Appendix II of the Bonn Convention, Appendix III of the Bern Convention and is on the Green List of Species of Conservation Concern.

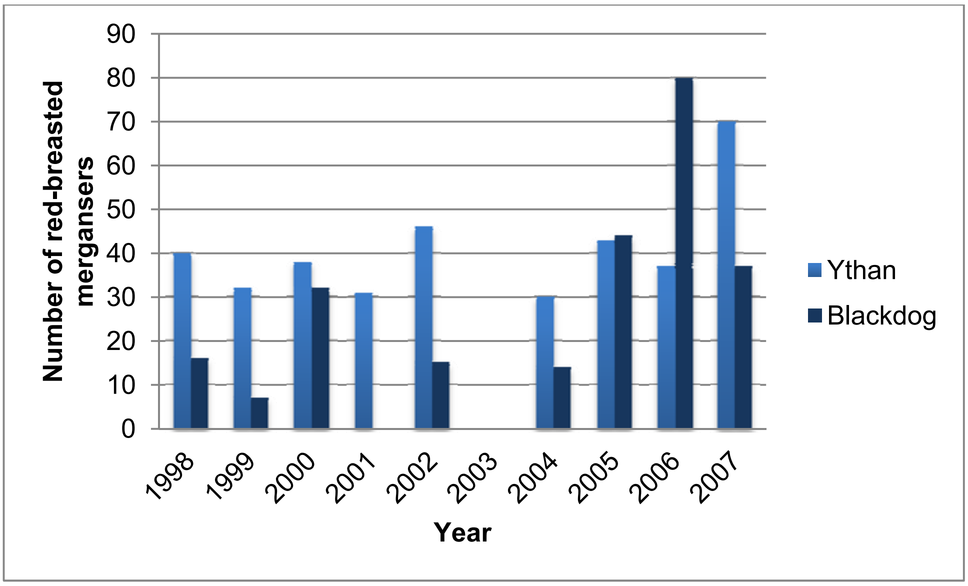
4.14.2 Background

Red-breasted merganser		
GB Population	Breeding: 2,400 prs. Winter: 10,200 ind.	Birdlife 2004
Scottish population	Breeding: 2,000 prs. Winter: 8,500 ind.	Forrester *et al*. 2007.
International threshold	1,700 ind.	Calbrade *et al.* 2010
GB threshold	84 ind.	Holt *et al.* 2011
Designated east coast sites where species is a noted feature	Firth of Forth	SNH 2011b
European population estimate	Breeding 59,818 – 84,484 prs. Wintering – 89,000 ind.	Hagemeijer and Blair 1997 Birdlife 2004
European population trend	Status 'secure' Trend 'small decline'	Birdlife 2004
World population	510,000 – 610,000	Birdlife 2011

Red-breasted merganser breed across northern Europe with the largest populations occurring in Scandinavia. In Scotland there is an estimated 2,000 pairs. The UK wintering population is estimated to 10,200 individuals, of which 8,500 occur in Scotland; dispersed around the coasts with the main wintering areas in the Moray Firth, Firth of Forth, St Cyrus and Montrose Basin and the Scottish west coast. During August and September adult red-breasted mergansers undergo a wing moult and become flightless for a period. During this period they congregate in flocks in regular areas including the Cromarty Firth, Inner Moray Firth and in Aberdeen Bay. These birds are thought to originate from the UK breeding population (Wernham *et al.* 2002). There is evidence of migration during the spring and autumn with peak passage during March/April and October and these birds may originate from Iceland or possibly central Europe (Forrester *et al*. 2007; Wernham *et al.* 2002).

Outwith the breeding season between 85% and 90% of red-breasted merganser occur along coasts and estuaries feeding on a variety of fish species (Cork Ecology 2004a).

In North-east Scotland red-breasted merganser is a scarce breeder with an estimated population of between 25 and 50 breeding pairs (Marquis 2011). Outwith the breeding season red-breasted merganser occur widely along the coast in generally low numbers. However peak numbers occur at St Cyrus where up to 500 red-breasted merganser occur during August and September (NESBR), Loch of Strathbeg, Ythan Estuary and Aberdeen Bay hold smaller numbers with peak numbers in Aberdeen Bay during July and August (Figure 4-21). The numbers present in the region during this period is greater than the North-east Scotland breeding population and so they must originate from elsewhere (Marquis, 2011).



(Source NESBR)

Figure 4-21: Peak numbers of red-breasted merganser in Aberdeen Bay between 1998 and 2007.

Peak numbers pass Peterhead throughout the year but highest numbers occur during March and April with up to 2.4 birds per hour with most sightings within a few hundred metres from shore and nearly all sightings within 1 km from shore (Innes 1995).

Boat-based surveys

During boat-based surveys, one red-breasted merganser was recorded in March 2008 at the Donmouth and one 2.7 km east of Drums in June 2011 (IECS 2008; SMRU 2011c).

Vantage Point surveys

Data from vantage point Counts undertaken between April 2006 and March 2008 recorded peak numbers of red-breasted merganser in October and November when up to four birds per hour were recorded passing the Donmouth in October 2007 and up to nineteen birds were recorded in April 2006 (Alba Ecology 2008b; EnviroCentre 2007).

Out of the 84 sightings of birds in flight there was only one record of a bird flying above 30 metres. At Blackdog most sightings were of birds between 1–2 km from the shore, whereas at the Donmouth birds were recorded out to 3 km (Alba Ecology 2008b).

Bird Detection Radar

A total of 51 red-breasted merganser were recorded during five days of surveys at Drums and Easter Hatton in October 2005. Fourteen were at Drums and 37 at Easter Hatton. Birds were recorded out to 3 km from shore but the majority were within 2 km, with peak numbers within 500 m of the coast. The mean flight height was 14 m with one record of birds at 40 m (Walls *et al.* 2006).

Red-breasted mergansers were frequently recorded during the 17 days of radar surveys undertaken at Blackdog in April 2007. A total of 31 records of 76 individuals were recorded with a mean flock size of two and a peak count of seven birds (Simms *et al.* 2007). All birds were seen flying below 30 m above sea surface and the majority, 60, of sightings were of birds flying south.

4.14.3 Summary of Results

There was one sighting of red-breasted merganser from the boat-based surveys but they were regularly recorded from land-based studies with peak numbers in October and November. The majority of birds were within 2 km of the coast with most within 500 m.

Of those recorded in flight all but two were recorded flying below 30 m.

No counts during any surveys undertaken across Aberdeen Bay were of national importance.

4.14.4 Species Sensitivities

Qualifying species

Red-breasted Merganser is a qualifying species as part of waterfowl assemblages: Firth of Forth SPA, a site with a 5 year mean peak count of 410 individuals (Calbrade *et al*. 2010).

Flight height

No flight heights were obtained from boat-based surveys undertaken in Aberdeen Bay. One was recorded as flying above 30 m from vantage point surveys and one from radar surveys. However, the mean flight height was recorded as being 14 m.

Elsewhere in the UK 10% of all flights have been recorded at rotor height (n=71).

Collision risk

Results from site specific boat-based and land-based surveys and other data sources indicate that red-breasted merganser are widespread in Aberdeen Bay and occur out to 3 km from shore. Consequently, they are at risk of interacting with the proposed development.

At other offshore wind farms, over 9,000 red-breasted mergansers were recorded in the Kalmar Sound and although birds were recorded flying through the wind farms there were no recorded collisions. There was also clear evidence of avoidance behaviour with a four-fold decrease in the number of mergansers flying through zone post-construction (Peterrson 2006).

The majority of red-breasted mergansers were within 2 km of the shore and therefore not at risk of collision. Furthermore, most sightings were of birds flying below 25 m and evidence from operating wind farms has indicated a very high avoidance rate. Therefore, the risk of a significant impact arising due to collisions is low and the significance of any impact, should it occur, would be negligible.

The only SPA in the region for which red-breasted merganser is a qualifying species is the Firth of Forth SPA which lies over 130 km away. Based on the number of sightings within the development area from boat-based surveys the probability of birds from this SPA flying through the proposed development area at turbine height is low and consequently the risk of collision is also very low. Therefore there will not be an adverse effect on the population due to collision.

Barrier effect

Studies undertaken in Sweden and Denmark have not shown any significant barrier effect with red-breasted mergansers having been recorded crossing turbines more so than for other species (Pettersson 2005; Zucco *et al*. 2006). Therefore, barrier effects are not predicted to occur in Aberdeen Bay where few red-breasted mergansers were recorded within the proposed development area. The potential impact, should it occur is long-term and of negligible magnitude and significance.

Displacement

Only two red-breasted mergansers were recorded from boat-based surveys undertaken within the bay. Studies undertaken in Denmark recorded 98% of red-breasted mergansers in water depths of 10 m or less. Therefore, the occurrence of red-breasted mergansers within the proposed development area is unlikely (Petersen *et al.* 2006). Results from studies undertaken in Sweden suggest that operating wind farms cause little or no displacement with birds occurring within 1 km of the wind farm (Pettersson 2006). Results from post-construction surveys undertaken in Denmark indicated an increase in numbers within the wind farm area post-construction compared to pre-construction (Petersen *et al.* 2006).

Based on the distribution of red-breasted mergansers in Aberdeen Bay and evidence from other sites then it is predicted that the magnitude and significance of any impact, should it occur, will be negligible there will not be an adverse effect or significant impact from the proposed development on red-breasted merganser due to displacement from the wind farm area.

Disturbance

Studies undertaken in Sweden concluded that although red-breasted mergansers could be disturbed by vessels, they returned to areas once the vessels departed usually with 30 minutes (Petterrson 2006). There will be both construction traffic and maintenance vessels associated with the proposed development. These may cause some disturbance to red-breasted mergansers when on site but this will be temporary. The numbers of red-breasted merganser recorded within the proposed development area were very low and it is therefore predicted that disturbance from either construction or service vessel will have a negligible, short term (from construction vessels) or long-term (from service vessels) impact of negligible magnitude or significance and not cause an adverse effect.

Cumulative and in-combination

Aside from the historical and on-going levels of shipping, there are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on red-breasted merganser present within Aberdeen Bay. There is not predicted to be any cumulative or in-combination impacts arising at other planned developments as their locations offshore and their water depths indicate that red-breasted merganser may not regularly occur in these areas. No red-breasted mergansers were reported during studies undertaken at the Beatrice demonstrator wind farm or Beatrice Offshore Wind Farm (BOWL 2012; Talisman 2005). Consequently, there are unlikely to be any cumulative or in-combination impacts.

Table 4-26: summary of significance of potential impacts on red-breasted merganser.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	High	Negligible	Medium	Negligible
Operation	Collision	Medium	Negligible	Long-term	Negligible
	Displacement	High	Negligible	Long-term	Negligible
	Barrier	High	Negligible	Long-term	Negligible
Decommissioning	Displacement	High	Negligible	Medium	Negligible
Cumulative	All	High	Negligible	Long-term	Negligible

4.14.5 Conclusions

Habitats Appraisal

Based on the evidence from existing offshore wind farms indicating a very low collision risk potentially little or no displacement and no significant barrier effects there will not be any adverse effects on the SPAs for which red-breasted merganser is a qualifying species.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental effect arising from the proposed development on red-breasted merganser.

4.15 Red-throated diver (*Gavia stellata*)

4.15.1 Protection and Conservation Status

The red-throated diver is listed in Annex I of the Birds Directive, Appendix II of the Bern Convention, Appendix II of the Bonn Convention, Schedule 1 under the Wildlife and Countryside Act, 1981 and is on the Amber List of Species of Conservation Concern.

4.15.2 Background

Red-throated diver		
GB Population	Breeding: 1,014 – 1,551 prs. Winter: 17,000 ind.	Calbrade *et al*. 2010
Scotland	Breeding: 1,000 – 1,500 prs. Winter: 2,270 ind.	Forrester *et al.* 2007
International threshold	3,000 ind.	Calbrade *et al*. 2010
GB threshold	170 ind.	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	Firth of Forth SPA 317 ind.	SNH 2011b JNCC 2011a Calbrade *et al*. 2010
European population estimate	Breeding 32,000 – 92,000 Wintering >51,000	Birdlife 2004
European population trend	Status: 'Depleted' Trend: 'stable'	Birdlife 2004
World population	200 – 590,000 'adults'	Birdlife 2011

Red-throated divers are relatively common around the Scottish coasts and spend much of the year at sea only coming onto fresh water during the breeding season. The species is entirely coastal in its wintering distribution, often being associated with shallow coastal inshore sandy bays during the winter months (Lack 1986). The major prey items are crustaceans, sandeels, sprat, herring, flatfish and codling and, as the name of the species suggests, these items are obtained by diving. The majority of wintering individuals are located down the east coast of Britain. Recent findings from aerial survey data have estimated the UK wintering population of this species to be now in the region of 17,000 birds (O`Brien *et al.* 2008).

Red-throated divers are a very rare breeding species in North-east Scotland with less than five pairs breeding in any one year (Cook 2011). However, they are a common wintering and passage species around all coasts (NESBR).

Historically peak numbers of red-throated diver occurred during the late autumn and early winter periods with a peak count of 1,470 birds between Donmouth and Collieston in October 1979 (Buckland, Bell and Picozzi 1990). In more recent years Aberdeen Bay has held up to 384 red-throated divers during a peak spring period between March and May (Figure 4-22).

Outwith the peak spring period, red-throated diver occur in lower numbers throughout the year particularly during the summer months. There is also an increase in numbers during the autumn with birds returning from their more northerly breeding grounds. Counts of up to nearly 180 birds have been recorded in the bay during September (Lewis *et al.* 2008). Results from studies undertaken by JNCC in 2005/06 indicated that the distributions of red-throated diver within the bay may vary slightly across the year. Peak counts are most frequent between the Donmouth and Balmedie and at the Newburgh Bar at the mouth of the Ythan Estuary. There are very few records of any red-throated divers in water depths of greater than 20 m (Söhle *et al.* 2006; Lewis *et al*. 2008).

Three aerial surveys undertaken by the JNCC in Aberdeen Bay between December 2005, January 2006 and May 2006 recorded a maximum of 39 red-throated divers in May (Söhle *et al.* 2006).

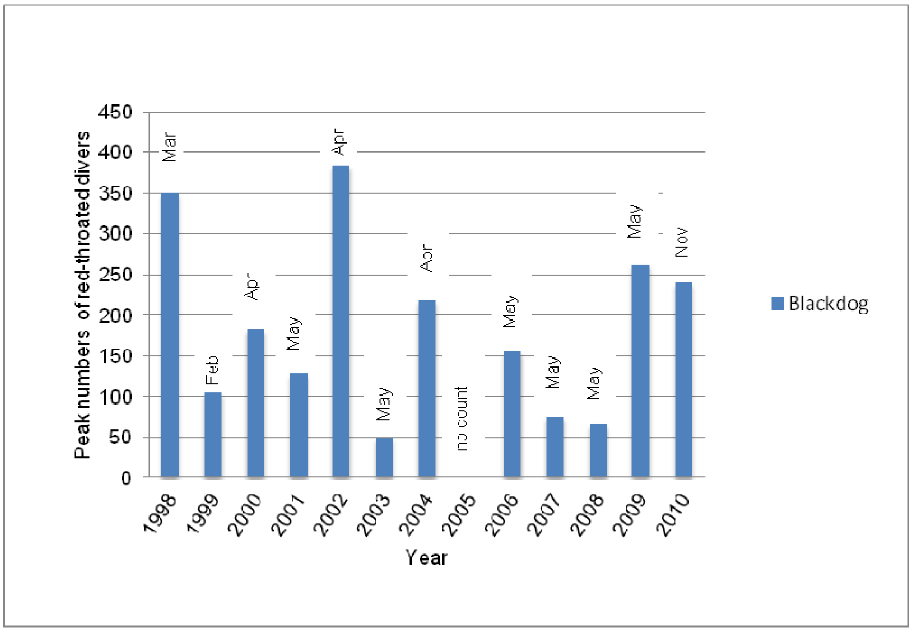


Figure 4-22: Peak numbers of red-throated diver recorded in Aberdeen Bay between 1998 and 2010 (Source NESBR; RSPB 2011).

Boat-based surveys

Boat-based surveys were undertaken on a monthly basis between February 2007 and April 2008 (Year 1 data) and from August 2010 to August 2011 (Year 2 data). The surveys recorded red-throated divers throughout the year in Aberdeen Bay with the majority of sightings during the spring and autumn and relatively few between June, July and August. The majority of sightings were in waters less than 10 m and within 1 - 2 km of the coast.

Analysis of the boat-based data collected between February 2007 and January 2008, undertaken by the Sea Mammal research Unit (SMRU) using Distance Sampling techniques, recorded peak estimated abundance during the winter months with an estimated abundance within the proposed EOWDC survey area of 38 birds in December and January and 47 birds in February and relatively lower numbers of less than 30 birds in spring. Densities were also higher in the winter with up to 0.9 birds/km^2 in the proposed EOWDC area (Table 4-27, Figure 4-24) (SMRU 2011a).

Table 4-27: Monthly estimates of density and abundance of red-throated diver in the proposed EOWDC and 'control' areas 2007 – 2008 (using *Distance* sampling).

Month	Location	Density Estimate (km^2)	SE	Estimated Abundance	SE	No. Observations
January	EOWDC	0.744	0.354	38	18.0	15
	Control	0.134	0.072	7	3.6	3
February	EOWDC	0.927	0.302	47	15.3	26
	Control	0.238	0.119	12	6.0	11
March	EOWDC	0.178	0.112	9	5.7	4
	Control	0.399	0.218	20	11.1	9
April	EOWDC	0.404	0.150	21	7.6	19
	Control	0.272	0.121	14	6.1	12
May	EOWDC	0.482	0.490	25	24.9	6
	Control	0.045	0.045	2	2.3	1
June	EOWDC	0.385	0.262	20	13.3	6
	Control	0.456	0.270	23	13.7	9
July	EOWDC	0.134	0.102	7	5.2	2
	Control	0.128	0.112	6	5.7	3
August	EOWDC	0.268	0.271	14	13.8	1
	Control	0.000	0.000	0	0.0	0
September	EOWDC	0.089	0.061	5	3.1	2
	Control	0.152	0.094	8	4.8	4
October	EOWDC	0.178	0.091	9	4.6	4
	Control	0.179	0.103	9	5.2	4
November	EOWDC	0.277	0.140	14	7.1	6
	Control	0.089	0.090	5	4.6	2
December	EOWDC	0.749	0.311	38	15.8	16
	Control	0.149	0.078	8	4.0	3

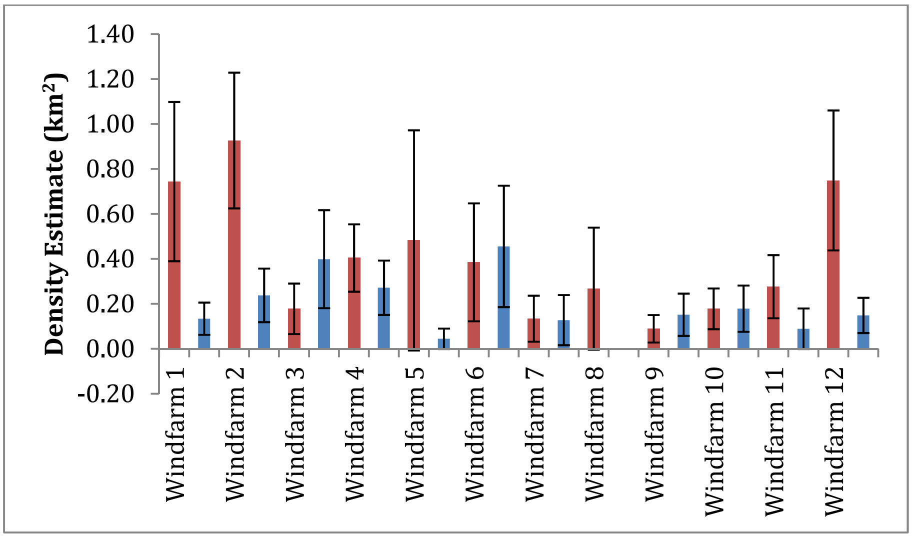


Figure 4-23: Monthly density estimates using *Distance* (+/- SE) of red-throated divers in the proposed EOWDC and 'control' Areas. February 2007 – January 2008 (1-12 refers to months).

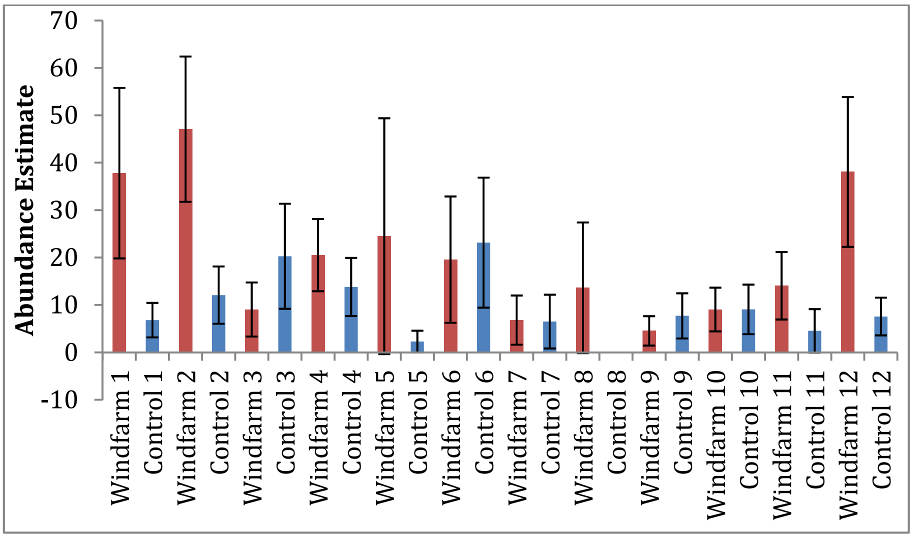


Figure 4-24: Monthly abundance estimates using *Distance* (+/- SE) of red-throated divers in the proposed EOWDC and 'control' Areas; February 2007 – January 2008 (1-12 refers to months).

Distribution maps from boat-based surveys indicate that red-throated divers exhibit a preference for water shallower than 20 m, but with concentrations observed on the 'short legs' of the survey, around the 5 m to 10 m depth contour line (Appendix B).

Boat-based data collected between August 2010 and August 2011 recorded a peak abundance estimate using *Distance* sampling techniques of 190 red-throated diver at a density of 1.26 birds/km^2 in the northern survey area during November 2010 with very low abundances to the south or offshore (Table 4-28) (SMRU 2011c).

Densities and abundance estimates are presented on a monthly basis in Figure 4-25 and Figure 4-26.

The data from Year 2 boat-based surveys indicate that peak densities and abundance occurred in Aberdeen Bay during the winter months between November and March.

Most sightings of red-throated diver in year 2 were recorded less than 2 to 3 km from the coast with few sightings further offshore. Red-throated divers were recorded within the proposed development area and to the north, with relatively lower numbers to the south and no abundance estimates possible (Appendix B). Peak numbers were recorded between November and March.

Table 4-28: Density, abundance and cluster size estimates for red-throated diver per study strata and per month (2010-2011)

Strata	Month	Density estimate	% CV	Abundance estimate	% CV	Cluster size	% CV
North	January	0.70	31.31	106	31.31	1.84	19
	February	0.43	62.34	65	63.24	2.22	55
	March	0.31	33.88	47	33.88	1.31	13.37
	April	0.03	99.62	4	99.62	1.00	
	June	0.07	120.56	11	120.56	3.00	66.67
	July	0.01	100.18	2	100.18	1.00	
	August	0.11	77.89	17	77.89	1.50	14.91
	September	0.05	100.26	8	100.26	2.00	0
	November	1.26	44.86	190	44.86	2.18	14.35

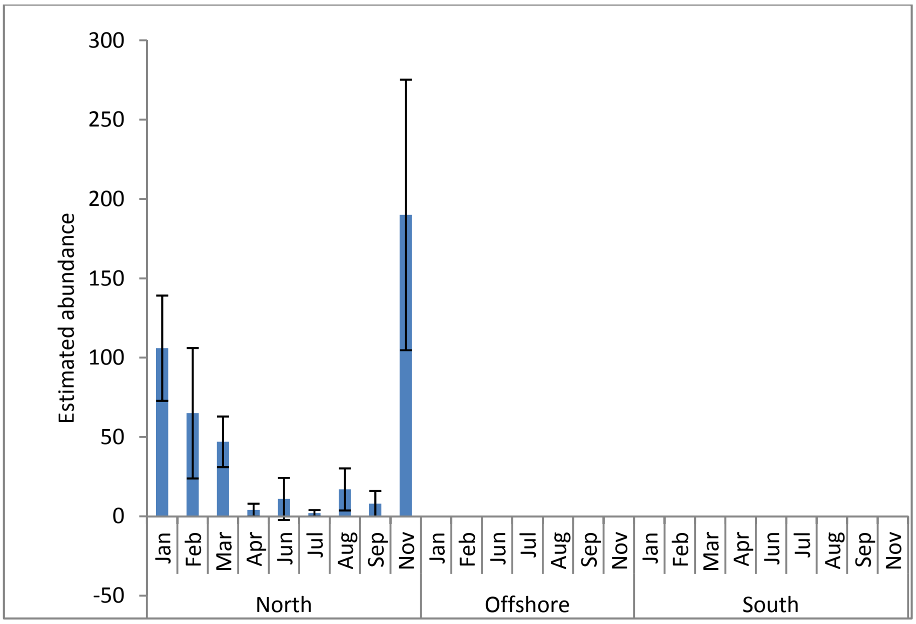


Figure 4-25: Abundance estimates ± CV for red-throated diver in each study strata and in each month (August 2010 – August 2011).

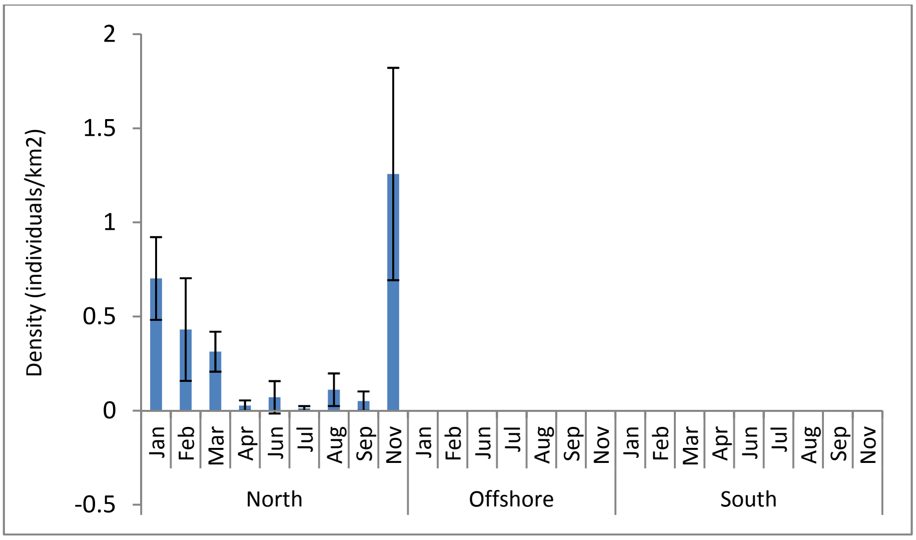


Figure 4-26: Density estimates (individuals/km2) ± CV for red-throated diver in each study strata and in each month (August 2010 – August 2011).

Most sightings during this period were to the north of the proposed development area (Appendix B).

Vantage Point surveys

Data from vantage point surveys were collected in Aberdeen Bay between April 2006 to March 2008.

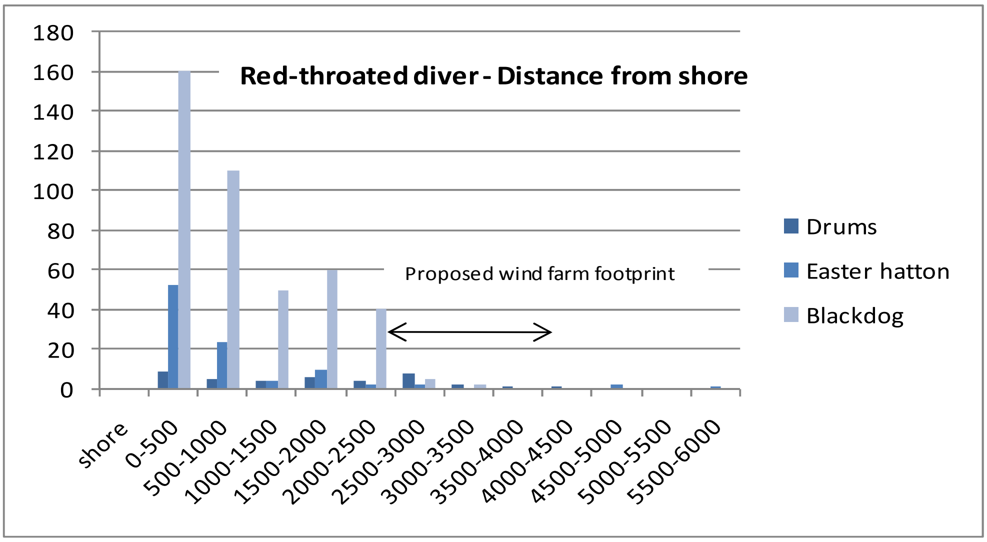
The results indicate a strong seasonal variation across the year with peak numbers occurring in the bay during April and May with a mean of up to 40 birds/hour passing in April 2007 (Alba Ecology 2008a). Red-throated divers were seen at all Vantage Point locations, mainly within 1 km or out to 2 km from shore with most records from Drums and Balmedie and generally lower numbers at Blackdog and Donmouth.

Of those recorded in flight from vantage point surveys, between 3% and 16% were between 30 to 150 metres above the sea suface, i.e at potential rotor height.

Bird Detection Radar

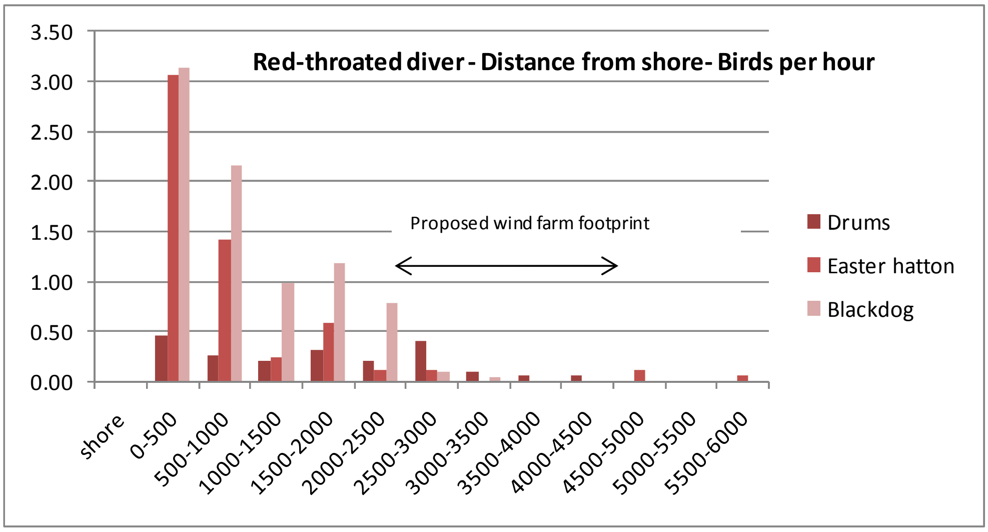
Observations made during radar studies undertaken in October 2005 a total of 157 red-throated divers were recorded, of which 65 were at Drums and 95 were at Easter Hatton (Walls *et al* 2005). Peak numbers were recorded within 500 m from shore although small numbers were recorded out to 5.5 km. Of those recorded in flight the mean height was 5 m with a maximum height of 40 m (Walls *et al.* 2006).

In April 2007 further surveys were undertaken at Blackdog for a period of 17 days. During this time a total of 427 birds were recorded usually as singles with a maximum flock size of four birds (Simms *et al.* 2007). The majority of sightings were of birds within 1.5 km of the coast, although birds further offshore may have been missed (Figure 4-27, Figure 4-28).



(Adapted from Walls *et al.* 2006, Simms *et al.* 2007)

Figure 4-27: Distances from shore for red-throated diver from three locations in Aberdeen Bay during surveys undertaken in October 2005 (Drums and Hatton) and April 2007 (Blackdog).



(Adapted from Walls *et al.* 2006, Simms *et al.* 2007)

Figure 4-28: Number of red-throated diver per hour and distance from shore from three locations in Aberdeen Bay during surveys undertaken in October 2005 (Drums and Hatton) and April 2007 (Blackdog).

4.15.3 Summary of Results

Red-throated diver occur throughout the year in Aberdeen Bay with peak numbers occurring during the winter and spring periods. Peak numbers of red-throated diver recorded within the proposed EOWDC survey area was 93 in May 2007 and peak density of 0.9 birds/km^2 in February 2007. Further surveys identified potentially main areas for red-throated diver to the north of the proposed development where densities of up to 1.26 birds/km^2 were recorded during November 2010 and a peak population estimate of 190 individuals. Data obtained from boat-based surveys supports the findings from the vantage point and radar studies that most red-throated diver occur within 2 km of the shore and in water depths of less than ten metres. Estimated numbers of red-throated diver recorded in Aberdeen Bay were below the threshold for a site of international importance but the bay may, on occasions, hold nationally important numbers.

4.15.4 Species Sensitivities

Qualify species

SNH have identified seven SPAs for which red-throated diver are a qualifying species during the breeding season but may have possible connectivity with the proposed development outwith the breeding season:

- Caithness and Sutherland Peatlands – 89 pairs
- Hoy – 58 territories.
- Orkney Mainland Moors – 18 pairs
- Foula – 11 pairs.
- Hermaness Saxavord and Valla Field – 26 pairs
- Otterswick and Graveland – 26 pairs
- Ronas Hill North Rona and Tingon – 56 territories

Note. Numbers of breeding pairs are those at the time of citation. More recent site specific population estimates are not published.

Combined, the seven SPAs held at the time of citation 284 pairs (568 individuals).

Flight height

Red-throated diver typically fly low and just above wave height. Site specific data obtained from boat-based surveys recorded 191 red-throated divers in flight, of which 4.71% were flying above 25 m. The generic flight height figures published in Cook *et al*. (2012*)* model 3.21% of red-throated divers at turbine height. Evidence from other locations have recorded 99.6% of red-throated divers as flying below 30 m (LAL 2005, RBA 2005).

Collision risk

Results from site specific monitoring obtained from boat-based and land-based surveys and other data sources indicate that red-throated diver are widespread and frequent within Aberdeen Bay. There is potential for movement across the bay and their use of sea areas depends on sea conditions (RSPB 2011).

In order to determine potential effects of collision on red-throated diver a collision risk assessment has been undertaken (Appendix A1).

The collision risk modelling predicts between zero and one red-throated diver to collide with the proposed development depending on the avoidance rate.

Table 4-29: Red-throated diver predicted collision mortalities per year.

Rochdale	Flight height data source	Avoidance rate (%)			
		95.0	98.0	99.0	99.5
Original	EOWDC	1 +/- 1.99	1 +/- 0.80	0 +/- 0.40	0 +/- 0.20
	Generic	1 +/- 1.36	1 +/- 0.54	0 +/- 0.27	0 +/- 0.14
Revised	EOWDC	1 +/- 1.76	0 +/- 0.70	0 +/- 0.35	0 +/- 0.18
	Generic	1 +/- 1.20	0 +/- 0.48	0 +/- 0.24	0 +/- 0.12

The peak population estimate for red-throated diver recorded in Aberdeen Bay from boat-based surveys is an estimated 190 individuals in November 2010 at a density of 1.26 birds/km^2 (SMRU 2011c).

The annual mortality rate for red-throated diver is 16% (BTO 2011).

Consequently, out of a population of 190 individuals in Aberdeen Bay, an annual mortality of 27 red-throated divers may be predicted. Therefore, 1% of the baseline mortality is 0.27 birds per year.

The Firth of Forth SPA has a wintering population of 317 individuals and therefore an annual mortality rate of 51 birds per year and a baseline mortality rate of 0.5 birds per year.

Based on the various scenarios and using a precautionary avoidance rate of 98%, it is predicted that less than one collision per year may occur (Table 4-29).

Studies undertaken at constructed offshore wind farms indicate that red-throated divers are at low risk of collision. Studies undertaken at Horns Rev and Nysted offshore wind farms in Denmark indicate that red-throated divers avoid wind farms. Of the 61 Divers tracked using radar none were recorded flying into the wind farm. Instead they were recorded as being deflected westward and flying around the wind farm (Petersen *et al*. 2006). Red-throated divers are therefore unlikely to come into direct contact with them (Petersen *et al*. 2006) and consequently the avoidance rate is likely to be higher than the precautionary 98%. Based on the results from existing wind farms it is predicted that the avoidance rate will be higher than 99% and therefore very few, if any, collisions are predicted.

Based on the results from the collision risk modelling predicting a low level of potential impact and evidence from other sites indicating avoidance behaviour, it is concluded that the potential impact of collision risk is temporally long-term and of negligible magnitude and significance.

There is potential for cumulative impacts from onshore wind farms (SNH 2012). However, it is not known where the red-throated divers in Aberdeen Bay originate from and therefore not possible to cumulatively assess potential impacts from onshore sites. However, based on the modelling, a potential increase of one mortality a year will not cause a significant incremental increase in cumulative impacts.

Barrier effect

Results from studies undertaken in Denmark indicate that red-throated divers may avoid flying through wind farms; consequently, there may be a barrier effect on red-throated divers within Aberdeen Bay. Should a barrier effect occur out to a distance of 1 km from the proposed development then a Diver may detour around the wind turbines causing it to increase its flight by a total of 3.2 km. Energetics modelling predicts that by flying around the proposed development the additional 3.2 km will cause an increase in energy usage of 8.5 Kj or 1% of daily energy expenditure (Speakman, Gray and Furness 2009).

Results from site specific surveys including boat-based surveys, radar studies and vantage point observations, or published literature (e.g. NESBR; Buckland, Bell and Picozzi 1990), have not reported any regular daily movement in the form of feeding or roosting movements across Aberdeen Bay by red-throated diver. Therefore, any increase in energy expenditure due to the avoidance of the wind turbines should it occur is not predicted to be on a daily basis. Consequently, any incremental increase in energy expenditure is likely to be *Ad hoc* and not a regularly occurring event. An increase in potential daily energy expenditure of 1% is small and likely to be within the range of natural daily variations of flight activity and energy expenditure. It is therefore not considered to be significant and the likely predicted effects from potential barrier impacts are considered to be temporally long-term of negligible magnitude and minor significance.

Displacement

Red-throated divers were considered to be at high risk of displacement in the review undertaken by Langston on the potential impacts of wind farms (Langston 2010) and evidence from existing offshore wind farms indicate a potentially high but not total displacement (e.g. Gill *et al*. 2008). Based on this, a range of high displacement figures of between 70% and 90% of red-throated diver has been considered for this assessment (Table 4-32).

Peak red-throated diver densities from boat-based surveys within the surveyed area that includes the proposed EOWDC site was 1.26 birds/km^2 (Table 4-28).

Based on the results obtained from boat-based surveys and that up to 90% of red-throated divers may be displaced then between 0 and 5 red-throated diver may be impacted from proposed development area alone and between 0 and 41 individuals if displacement occurs out to 2 km (Table 4-30).

Data from onshore counts, published in North-east Scotland Bird reports (NESBR), indicate that numbers of red-throated diver in Aberdeen Bay may, during peak periods, be higher than has been recorded from boat-based surveys. Recent peak counts of 262 red-throated divers have been reported in May 2009 (Figure 4-22).

The total area of Aberdeen Bay from Collieston to Aberdeen and out to 4 km is approximately 95 km^2 and therefore a peak density of 2.7 red-throated diver/km^2 may occur across the bay during peak passage periods. However, this assumes an even distribution across the Bay, which may not be the case as higher numbers have been recorded from boat-based surveys to the north (Appendix B).

Based on densities of red-throated diver derived from *ad hoc* land based observations and published in the North-east Scotland Bird Report and assuming that up to 90% of red-throated divers may be displaced, then between 0 and 11 red-throated diver may be impacted from proposed development area and between 0 and 90 individuals, if displacement occurs out to 2 km (Table 4-30).

Peak numbers of red-throated diver occur in Aberdeen Bay during passage periods (NESBR) with lower numbers recorded at other times, particularly during the summer months. During periods of peak densities red-throated divers will pass through the area to and from their breeding or wintering grounds and any displacement effect will consequently be temporary as the birds pass through the region. Red-throated divers occur widely across Aberdeen Bay and around Scottish coasts and any displacement from an area will mean individuals will forage elsewhere. Site specific survey results indicate that areas to the north of the proposed development area are more regularly used by red-throated diver and that displaced red-throated divers may relocate to this area. This may cause an increase intra-specific competition should there be limited prey availability.

Red-throated divers feed on small fish such as herring and sprat. Monitoring studies on the effects on fish from offshore wind farms indicate that there is little effect on fish from offshore wind farms (e.g. Lindeboom *et al*. 2011) and consequently, should red-throated divers be displaced it is predicted that prey will be available outwith the proposed EOWDC area during the period of construction and that fish will return following cessation of any piling activities (See Appendix 9.1 *Marine Ecology Baseline* and 9.2 *Marine Ecology EIA*).

The mean maximum foraging range for red-throated diver is 12.21 km with a maximum range of 50 km (BirdLife International 2012). Consequently, breeding red-throated divers from SPAs will not be impacted during the breeding season. Following breeding, red-throated divers disperse widely with birds from Shetland and Orkney recorded around the coast of Scotland, England, Ireland, France and

Netherlands (Okill 1994; BTO 2012). Birds wintering in North-east Scotland may be Scottish breeding birds as well as from Greenland or elsewhere (Okill 1994; Wernham *et al*. 2002).

If it is assumed that all red-throated divers breeding in SPAs winter in Scottish waters (which ringing data indicates is not the case), then out of a total Scottish wintering population of 2,270 individuals, 25% are from the SPAs in Orkney, Shetland and Caithness. Consequently, if a total of 90 red-throated divers are displaced from the proposed development area, 25% may be from the relevant SPAs, i.e. 22 birds out of a breeding population of 568 individuals.

Based on site specific data and results from other sites it is concluded that the impact of displacement from the physical presence of the turbines is long-term and of potentially moderate significance, depending on the scale of displacement.

However, peak numbers of red-throated diver typically occur during the spring passage period when birds are moving to their breeding grounds. The duration of any displacement effect on any individual red-throated diver is potentially for a relatively short period of time as the birds pass through Aberdeen Bay. Further more the birds that are displaced will be able to relocate elsewhere within Aberdeen Bay and therefore will not be affected by any displacement. Consequently, although the impact may moderate in terms of displacement the actual impact the Diver population within Aberdeen Bay is predicted to be of negligible or minor significance.

Table 4-30: Potential number of red-throated diver displaced by the proposed development based on boat-based data and land-based observations.

% Impacted	Displacement (development area) Boat-based data			Displacement (development area + 2 km buffer) Boat-based data			Displacement (development area) NESBR data			Displacement (development area + 2 km buffer) NESBR data		
	70%	80%	90%	70%	80%	90%	70%	80%	90%	70%	80%	90%
0%	0	0	0	0	0	0	0	0	0	0	0	0
10%	0.5	0.4	0.45	4.6	3.68	4.14	1.2	0.96	1.08	9.96	7.96	8.96
20%	0.7	0.8	0.9	6.44	7.36	8.28	1.68	1.92	2.16	13.94	15.93	17.92
30%	1.05	1.2	1.35	9.66	11.04	12.42	2.52	2.88	3.24	20.91	23.90	26.89
40%	1.4	1.6	1.8	12.88	14.72	16.56	3.36	3.84	4.32	27.88	31.87	35.86
50%	1.75	2	2.25	16.1	18.4	20.7	4.2	4.8	5.4	34.86	39.84	44.82
60%	2.1	2.4	2.7	19.32	22.08	24.84	5.04	5.76	6.48	41.83	47.80	53.78
70%	2.45	2.8	3.15	22.54	25.76	28.98	5.88	6.72	7.36	48.80	55.77	62.74
80%	2.8	3.2	3.6	25.76	29.44	33.12	6.72	7.68	8.64	55.76	63.74	71.71
90%	3.15	3.6	4.05	28.98	33.12	37.26	7.56	8.64	9.72	62.74	71.71	80.67
100%	3.5	4	4.5	32.2	36.8	41.4	8.4	9.6	10.8	69.72	79.68	89.64

Disturbance

Red-throated divers are predicted to be disturbed by vessels both during construction and during operation from maintenance vessels. Previous studies have indicated that there may be total displacement from within 100 m of a vessel and varying degrees of displacement at distances up to 1,000 m. Some displacement may occur beyond 1,000 m but this is not reliably quantified or attributed to the survey vessel. The average displacement recorded is 82% of all birds within 1 km (Norman and Ellis 2005). When disturbed, divers respond to approaching vessels by low, direct flights usually perpendicular to the line of approach and that these flights are generally below 15 m (Norman and Ellis 2005).

During construction there may be a number of vessels operating within the area but will likely be focussed around a single point where the turbine is being installed. Consequently, based on studies undertaken during construction, up to 82% of the Divers may be displaced from within 1 km radius of the installation; an area of 3 km^2. Based on the highest recorded density of 1.26 birds/km^2, it is therefore predicted that up to 3 red-throated diver may be displaced from the vicinity during construction. This equates to approximately 1.5% of the red-throated diver population within Aberdeen Bay based on the peak population figure of 190 individuals recorded from boat-based surveys in November 2010. Based on data from North-east Scotland Bird reports (NESBR) and a density of 2.7 birds/km^2 a total of 7 birds may be displaced at any one time. This equates to approximately 2.6% of the red-throated diver population within Aberdeen Bay based on a peak population figure of 262 birds recorded from land-based observations in May 2009.

The construction period will be of short to medium duration and the impacts of construction vessels temporary. Consequently, any potential impact is predicted to also be of short to medium duration, localised of negligible magnitude and of minor significance.

Displacement by service boats within the EOWDC area assumes that red-throated divers are not already deterred from the area by the turbines. If red-throated divers are not displaced by the presence of the turbines then the presence of service boats may reduce the re-population of the site. It is not known exactly how many service vessels may be required but based on the scale of the proposed development it is predicted to be no more than four vessels on any one occasion. The presence of the proposed development in the vicinity of the intensively used Aberdeen Harbour means that the potential increase in vessel movement on a regular basis associated with the proposed EOWDC will not have any noticeable difference to the overall number of vessels already using Aberdeen Bay. Any specific displacement caused by the service vessels will be temporary as Divers will be able to move into the area once the vessel has passed or leaves the area. In addition, the wide distribution of Divers within the bay is such that there are alternative suitable sites that displaced Divers could utilise.

It is concluded that the effect of service boats is much smaller than assuming total displacement from the EOWDC area and the potential impact from disturbance is of low magnitude, long-term and of minor significance.

Cumulative Impacts

There is the potential for cumulative impacts with other offshore wind farms, planned or proposed and other activities such as shipping.

With respect to other wind farms, three occur in the Firth of Forth (Inch Cape, Neart na Gaoithe and Firth of Forth) in an area not known to hold significant numbers of red-throated diver. Consequently, there is not predicted to be any cumulative impact from these three wind farms.

Data from aerial surveys and site specific data at Beatrice indicate that the two wind farms planned in the Moray Firth (Beatrice and Moray Firth Offshore Wind Farms) are also in areas where red-throated diver may not occur (Söhle *et al*. 2006; Lewis *et al.* 2008; Brookes 2009). A total of five red-throated divers were recorded from two years of boat-based surveys undertaken at the proposed Beatrice offshore wind farm (BOWL 2012). Consequently, the likelihood of a cumulative impact arising is considered to be low.

There is the potential for a cumulative impact with respect to disturbance arising from other activities, notably vessel activities in the area. Although there will be an increase in vessel movements during the construction period, post-construction it is likely that there will be less than four vessels per day. This increase is within the day-to-day variation in the number of vessels operating in and out of Aberdeen Harbour and is therefore unlikely to be noticeable.

The potential future Ocean Laboratory will require additional vessel movements within the proposed development area during its construction and operation. Should this occur then there is the potential for a cumulative effect on red-throated diver. It is not yet known what type of structure the Ocean Laboratory may be or how it will be installed or the number of vessel movements will be required. However, it is a single structure and it is predicted that the level of disturbance will be no greater than that arising from the installation of a single wind turbine. The scale of disturbance is therefore predicted to be localised and of short duration.

It is concluded that the cumulative effect of service boats is much smaller than assuming total displacement from the proposed development area and the potential cumulative impact is minor.

Table 4-31: Summary of significance of potential impacts on red-throated diver.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Very High	Negligible	Medium	Minor
Operation	Collision	High	Negligible	Long-term	Negligible
	Displacement	Very High	Low	Long-term	Moderate
	Barrier	Very High	Negligible	Long-term	Minor
Decommissioning	Displacement	Very High	Negligible	Medium	Minor
Cumulative	All	Very High	Negligible	Long-term	Minor

4.15.5 Conclusions

Habitats Appraisal

No designated sites for which red-throated diver is a qualifying species have been identified as being at risk of an adverse effect.

Environmental Impact Assessment

Red-throated divers are widely distributed in Aberdeen Bay and in varying numbers. The assessment has been based on the peak densities and maximum counts recorded within the bay and is based on a series of worst-case assumptions.

Based on the low numbers of Divers recorded flying at turbine height, either within Aberdeen Bay or at other offshore wind farms, the collision risk for red-throated diver is very low and there is not likely to be a significant effect on the population arising from collision mortality rates.

There is the potential for up to 21% of the red-throated diver population within Aberdeen Bay to be displaced based on there being 90% avoidance of the EOWDC site out to 2 km. Based on land-based observations this increases up to 34%. Data obtained from boat-based and land-based surveys indicate that the proposed development is not a significant area for red-throated divers in Aberdeen Bay compared to areas of Aberdeen Bay to the north. Therefore, the percentage of the population potentially displaced may be lower than has been used in this assessment.

Disturbance from construction and maintenance vessels will occur but the impact will be localised and temporary. The number of predicted vessel movements associated with the proposed development are within the variable range of vessel activity associated with the intensively used Aberdeen harbour and unlikely to be noticed above the existing activities.

There may be some displacement of red-throated divers away from the proposed EOWDC area that may be of moderate significance based on a realistic worst-case scenario. However, it is predicted, based on site-specific survey data the likely level of impact from displacement will be lower than has been assessed and that displaced red-throated divers will be able to relocate without a significant negative impact and the predicted effect on the Diver population within Aberdeen Bay will be negligible or minor.

4.16 Northern Fulmar (*Fulmarus glacialis*)

4.16.1 Protection and Conservation Status

The (northern) fulmar is listed in Appendix II of the Bonn Convention, Schedule 1 under the Wildlife and Countryside Act, 1981 and is on the Amber List of Species of Conservation Concern.

4.16.2 Background

Fulmar		
GB Population	538,000 nests	Mitchell *et al* 2004
Scottish population	486,000 AoS	Forrester *et al.* 2007
International threshold	Unknown	-
GB threshold	5,000	1% of GB Pop[n]
Designated east coast sites where species is a noted feature	Fowlsheugh: 193 prs. Buchan Ness to Collieston: 1,370 prs. Troup Pennan and Lion's Heads: 1,795 prs (2007) Forth Islands: 402 prs. East Caithness Cliffs: 15,000 prs. (2000) North Caithness Cliffs: 16,310 prs. (2000) Copinsay: 1,123 AoS (2008) Fair Isle 27,896 AoS (2006) Sumburgh 203 AoS (2006)	JNCC (2011)
European population estimate	Breeding: 2.8 – 4.400,000 Wintering: 1,500,000	Birdlife 2004
European population trend	Status 'secure' Trend 'large increase'	Birdlife 2004
World population	15 – 30,000,000 'adults'	Birdlife 2011

Fulmars are one of the most abundant pelagic birds in the North Atlantic with a global population of up to 30 million individuals and a UK breeding population of over 500,000 individuals. The fulmar population has increased dramatically during the last couple of centuries and numbers in Britain doubled between 1969/1970 and 1985/1987 (Wernham *et al.* 2002).

After fledging, young fulmars spend up to four years at sea, during which time they are thought to disperse widely and rarely visit land (Wernham *et al*. 2002). They feed at sea, often scavenging behind fishing vessels.

The UK population is estimated to be 538,000 apparently occupied nests (AoN) and therefore in excess of a million birds, of which approximately 80% are in Scotland (Mitchell *et al*. 2004).

In North-east Scotland the fulmar first colonised the region in 1916 at Pennan Head and in 1920 at Fowlsheugh. The population in the region as a whole increased by 96% between 1969/70 and 1985/87 (Schofield 2011a) although some colonies increased at a greater rate, e.g. 118% in Moray, 136% between Banff and Buchan and 167% in Kincardine and Deeside (Mitchell *et al*. 2004).

During a ten year study of seabird movements at Peterhead, fulmars passed along the north-east coast throughout the year but were scarcest in winter, with a general pattern of a modest southward movement. In spring, numbers increase with the majority of birds heading north. In the autumn numbers of fulmars passing Peterhead decreased with the majority of birds still heading north (Innes 1992). During periods of poor weather the number of fulmars passing along the coast can be large with regular counts of over a 1,000 birds per hour during these periods (Buckland, Bell and Picozzi 1990).

Boat-based surveys

Fulmars were recorded widely across Aberdeen Bay throughout the year from boat-based surveys (Appendix B). In both years during which surveys were undertaken relatively low numbers of fulmars were recorded in the proposed development area in December and January with most sightings either to the north or south (Figure 4-29 Figure 4-30). During February and March numbers increased but mostly outwith the proposed EOWDC area. During the breeding season fulmars were recorded mainly to the south and offshore with low densities recorded within the proposed development area (Appendix B). Following breeding numbers in Aberdeen Bay decreased. Peak numbers of fulmar were recorded within the 'control' survey area to the north of the proposed EOWDC where up to 45 birds were recorded during December and 92 to the south in February 2011 (Figure 4-30 and Figure 4-31) (SMRU 2011c).

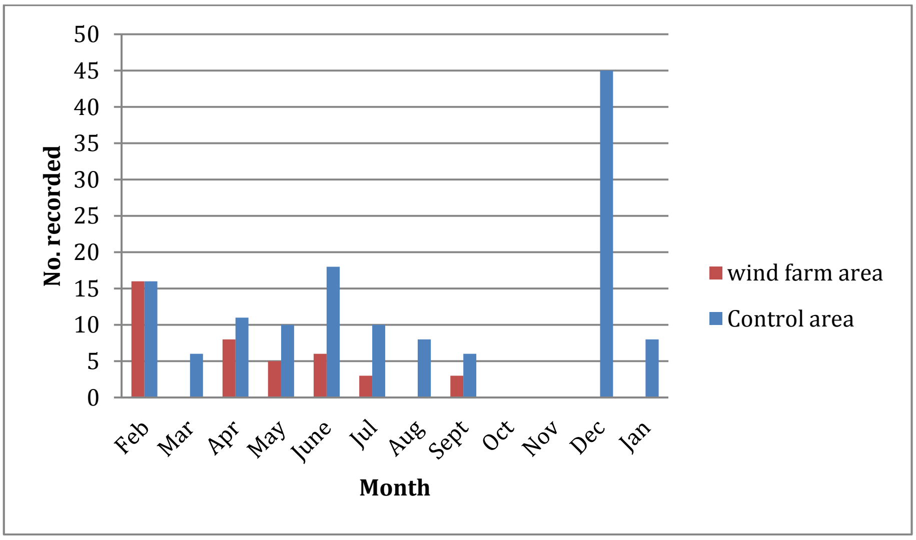


Figure 4-29: Fulmar monthly population estimates in proposed EOWDC and 'control' areas: Year 1 Boat-based surveys 2007 – 2008.

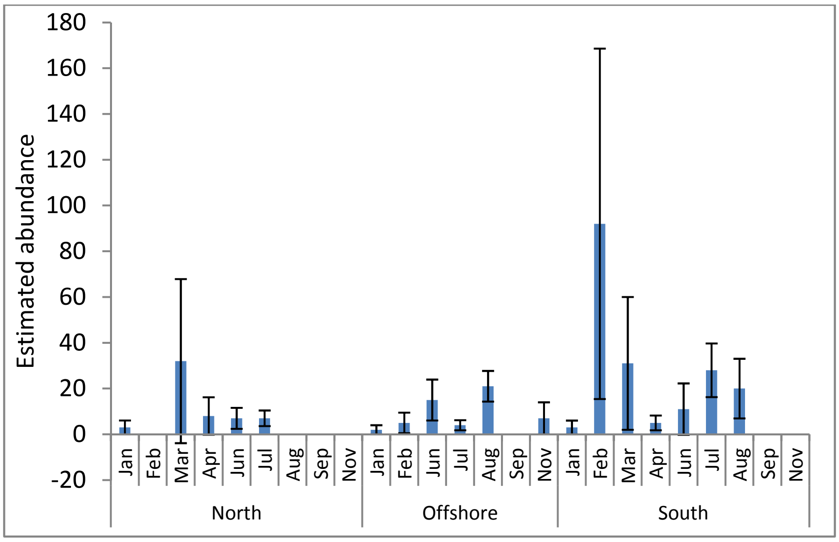


Figure 4-30: Abundance estimates of fulmar recorded from boat-based surveys undertaken in Aberdeen Bay between August 2010 and August 2011.

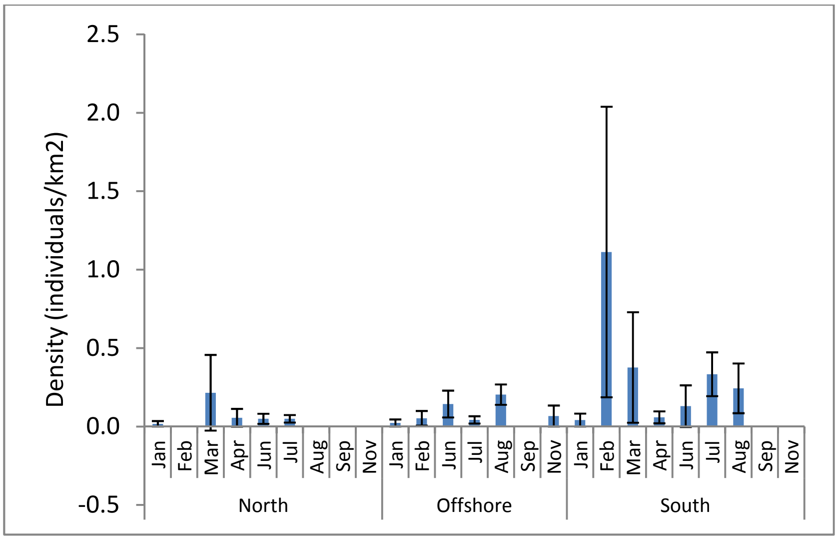


Figure 4-31: Density estimates (Individuals/km^2) for fulmar in each study strata and in each month (August 2010 to August 2011).

Vantage Point surveys

In Aberdeen Bay fulmars were present during peak dawn and dusk activity periods between April and September in numbers generally less than 20 birds per hour but occasionally up to 75 birds per hour during peak periods in June (Alba Ecology 2008a). This is considerably lower than the number of birds recorded at Peterhead during the same seasonal period where 300 to 400 birds per hour were recorded (Innes 1992).

Numbers of fulmar sighted within Aberdeen Bay decreased during the winter months with less than three birds per hour passing through any one vantage point site in Aberdeen Bay between October 2006 and March 2007. Twenty-five fulmars were recorded during a hundred hours of observations between October 2006 and March 2007 (EnviroCentre 2007) and twenty-four between October 2007 and March 2008 (Alba Ecology 2008b).

Most records during the winter months were of birds at least 1 km from the shore, with the majority being between 2 km and 3 km offshore. Of those recorded in flight at least 80% of all flights were below 30 m.

Bird Detection Radar

No fulmars were recorded during five days of observations undertaken at Easter Hatton and Drums during October 2005. Further studies undertaken at Blackdog over a seventeen day period in April 2007 observed 158 fulmars at a rate of three birds per hour (Simms *et al.* 2007).

4.16.3 Summary of Results

Fulmars occur throughout the year in Aberdeen Bay with peak numbers during the late summer, late winter and spring periods. Very few fulmars were recorded in nearshore waters during the post-breeding and early winter periods. Fulmars were more frequently recorded within the 'control' survey to the north and in offshore waters than within the proposed offshore EOWDC survey area, where there was a peak count of sixteen birds in February 2006. Results from the vantage point and radar studies suggest that the majority of fulmars occur between 2 - 3 km offshore and based on boat-based observations 0.6% of flights were at rotor height. The numbers recorded from boat-based and vantage point land based surveys were lower than the peak counts reported for Aberdeen Bay from other land based counts.

Numbers of fulmar recorded in Aberdeen Bay were below the threshold for a site of international importance.

4.16.4 Species Sensitivities

Qualify species

There are twenty-five SPAs for which fulmar is a qualifying species all of which are within the potential foraging range from the proposed development of 664 km (SNH 2011a).

- Buchan Ness to Collieston Coast,
- Fowlsheugh,
- Forth Islands,
- Troup, Pennan and Lion's Head,
- East Caithness Cliffs,
- North Caithness Cliffs Copinsay,
- Fair Isle,
- Sumburgh Head,
- Noss,
- Fetlar,
- Foula,
- Hermaness, Saxa Vord and Valla Field,
- Calf of Eday,
- West Westray,
- Rousay,
- Hoy,
- North Rona and Sula Sgeir,
- Cape Wrath,
- Handa,
- Shiant Isles,
- Flannan Isles,
- St Kilda,
- Mingulay and Berneray,
- Rathlin Island.

Of the 25 SPAs considered to have potential for connectivity with the proposed development for nine sites the connectivity is considered to be high or moderate based on the mean maximum foraging range (SNH 2011a).

- Buchan Ness to Collieston Coast
- Fowlsheugh
- Forth Islands
- Troup, Pennan and Lion's Head
- East Caithness Cliffs
- North Caithness Cliffs
- Copinsay
- Fair Isle
- Sumburgh Head

Fulmar populations at the time of designation or at the time of last review at each of the sites were:

- Buchan Ness to Collieston SPA held 1,765 apparently occupied nest (AoN); recent counts indicate a slight decline to 1,370 AoN.
- Fowlsheugh SPA held 1,170 AoN. Recent counts indicate a decline to 193 pairs in 2009.
- Forth Islands held 1,600 AoN. Recent counts indicate a decline to 402 AoN.
- Troup, Pennan and Lion's Head SPA held 4,400 AoN.
- East Caithness Cliffs 15,000 'pairs' (2000).
- North Caithness Cliffs 16,310 'pairs' (2000).

- Copinsay – 1,123 AoS (2008).
- Fair Isle – 27,896 AoS (2006).
- Sumburgh – 203 AoS (2008).

  Note – the 'recent counts' may not be complete and therefore the declines suggested may not be genuine decreases in breeding populations. Counts from the JNCC Seabird Monitoring Programme do not necessarily match the SPA colonies and may under-record the actual SPA population.

Flight height

Data obtained from boat-based surveys recorded less than 0.6% of fulmars flying above 25 m (n=919).

Data from other offshore wind farms have recorded over 28,000 fulmar. Modelling results based on a minimum rotor blade height of 20 m predict 4.8% of flights at rotor height (Cook *et al*. 2012).

Collision risk

Results from site specific boat-based and land-based surveys indicate that fulmars are widespread across Aberdeen Bay with increasing numbers offshore including within the proposed development area (Appendix B). 99.4% of sightings within Aberdeen Bay from boat-based surveys were of birds flying below 25 m and therefore not at risk of collision.

There is only one record of a fulmar collision with an offshore wind farm with one recorded at Blyth (Zucco *et al*. 2006). Evidence from other offshore wind farms indicate that fulmars fly predominantly below turbine height and are therefore not at significant risk of collision (Cook *et al.* 2011).

In order to determine potential effects of collision on fulmar a collision risk assessment has been undertaken (Appendix A1).

The CRM predicts between zero and seven fulmars may collide with the proposed development depending on the avoidance rate selected.

Table 4-32: Fulmar predicted collision mortalities per year.

Rochdale	Flight height data source	Avoidance rate (%)			
		95.0	98.0	99.0	99.5
Original	EOWDC	1 +/- 0.68	0 +/- 0.27	0 +/- 0.14	0 +/- 0.07
	Generic	7 +/- 5.11	3 +/- 2.05	1 +/- 1.02	1 +/- 0.51
Revised	EOWDC	1 +/- 0.78	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00
	Generic	5 +/- 3.99	2 +/- 1.56	1 +/- 0.78	0 +/- 0.00

Based on the various scenarios and using a precautionary avoidance rate of 98%, it is predicted that up to two collisions per year may occur (Table 4-32). The current SPA population across all nine SPAs is 64,262 AoN; approximately 128,524 adults.

The annual mortality rate for fulmar is 3% (BTO 2011). Consequently, out of a population of 128,524 individuals an annual mortality of 3,855 fulmars may be predicted. Therefore, 1% of the baseline mortality is 38.5 birds per year.

For the individual SPAs the increase in mortality that could cause an adverse effect is lower and depends on whether the population is in a favourable status or not. Of the nine SPAs that are considered to have high connectivity with the proposed development the fulmar populations are in favourable status for all but the Buchan Ness to Collieston Coast SPA and

Troup, Pennan and Lion's Heads SPA where they are in unfavourable and declining conditions.

Collision mortality during the breeding season (April to September) is, based on a 98% avoidance rate and the generic flight height modelling results predicted to be less than two birds per year. Based on site specific data is predicted to be zero. Therefore, the potential impact on any single SPA is predicted to be negligible.

The loss of up to two fulmars per year from either of the SPAs for which the population status is unfavourable may have an incremental increase in effect. However, the potential risk of any collision impact is very small and it is unlikely that all collisions will be from these two sites therefore the risk of an effect occurring is very small.

Based on the site specific data, collision risk modelling and evidence from existing offshore wind farms it is concluded that the risk of a significant environmental impact due to collision mortality is temporally long-term and of negligible magnitude and minor significance and not cause a significant or an adverse effect.

Barrier effect

The number of fulmars reported at operating wind farms is very low. The few records from Danish studies suggest that fulmars may avoid flying through the operating wind farm and consequently there may be a barrier effect (Petersen *et al.* 2006).

In order to avoid the turbines the birds may incur additional energetic expenditure. The proposed EOWDC is, at its longest point, approximately 4 km and at its widest 2 km. Assuming birds avoid the proposed development area at 1,000 m then they may incur an overall increase in flight distance of 3.2 km.

Fulmars are extremely efficient fliers and during the breeding season can travel many hundreds of kilometres with single feeding trips of up to 580 km and a mean maximum of 400 km (Thaxter *et al*. 2012). Outwith the breeding season fulmars forage widely across the North Sea and North Atlantic. Consequently, any additional increase in foraging distance due to avoidance of flying through the proposed development and its significance will be temporally long-term and of negligible magnitude and significance.

Displacement

Fulmars are primarily an aerial species spending relatively little time on the sea surface and do so primarily when preening or feeding or during periods of calm weather. There are no data available from constructed wind farms to determine whether fulmars are displaced from wind farms.

Data from boat-based surveys undertaken between 2007/2008 and 2010/2011 recorded a peak count of 16 fulmars in the proposed EOWDC survey area during February (Figure 4-29) at a density of less than 1.5 fulmar/km^2 (Figure 4-31). This is less than 0.1% of the SPA fulmar breeding population. Site specific data indicates that the proposed development area is not used extensively by fulmars. Fulmars forage over a wide areas in search of small fish (sandeels), crustaceans and squid and they also scavenge extensively around fishing vessels (Phillips *et al*. 2009). Consequently, it is predicted that should displacement occur fulmars will be able to forage elsewhere and the magnitude of the effect and its significance will be temporally long-term and of negligible magnitude and significance.

Cumulative and in-combination

The very large range that fulmars can fly suggests that any individual fulmar may interact with any of the proposed offshore wind farms in Scottish waters and elsewhere. Consequently, there is the potential for cumulative and in-combination effects. The closest constructed offshore wind farm is the Beatrice demonstrator project in the Moray Firth. Collision risk modelling undertaken for that project suggested that one fulmar every three years may collide with the turbines (Talisman 2005). Collision risk modelling undertaken for the proposed Beatrice offshore wind farm indicates up to 53 fulmars may collide per year (based on a 98% avoidance rate) (BOWL 2012). The risks of collision are low, nor are there predicted to be any impacts arising from barrier or displacement effects. The relatively low level of usage of the site indicates the potential for a cumulative or in-combination effect to be low and the magnitude temporally long-term and of negligible magnitude and significance.

Table 4-33: Summary of significance of potential impacts on fulmar

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Medium	Negligible	Medium	Negligible
Operation	Collision	Very High	Negligible	Long-term	Minor
	Displacement	Medium	Negligible	Long-term	Negligible
	Barrier	Medium	Negligible	Long-term	Negligible
Decommissioning	Displacement	Medium	Negligible	Medium	Negligible
Cumulative	All	Medium	Negligible	Long-term	Negligible

4.16.5 Conclusions

Habitats Appraisal

Based on the results from site specific surveys undertaken at the proposed development area, in particular the relatively low usage of the site along with evidence from existing wind farms, it is concluded that the proposed development will not have an adverse effect on fulmars as qualifying features for Buchan Ness to Collieston SPA, Fowlsheugh SPA, Forth Islands SPA, Troup, Pennan and Lion’s Heads SPA, East Caithness Cliffs SPA, North Caithness Cliffs SPA, Copinsay SPA, Fair Isle SPA and Sumburgh Head SPA.

Environmental Impact Assessment

Based on the very low usage of the site and the known behaviour of fulmar it is predicted that there will not be a significant environmental effect arising from the proposed development on fulmars.

4.17 Northern Gannet (*Morus bassanus*)

4.17.1 Protection and Conservation Status

The (Northern) gannet is listed in Appendix III of the Bern Convention, and is on the Amber List of Species of Conservation Concern.

4.17.2 Background

Gannet		
GB population	Breeding: 230,000 prs.	Mitchell *et al* 2004
Scottish population	Breeding: 182,511 AoS Winter: 'a few thousand'	Forrester *et al.* 2007
International threshold	Unknown	-
GB threshold	4,600 ind.	1% of GB Pop^{n}
Designated east coast sites where species is a noted feature	Forth Islands: 48,065 prs. Fair Isle: 3,582 AoN (2009)	JNCC
European population estimate	Breeding 300,000 – 310,000 prs. Wintering – unknown	Birdlife 2004
European population trend	Status 'secure' Trend 'large increase'	Birdlife 2004
World population	950,000 – 1,200,000 'adults'	Birdlife 2011

Gannets are widespread across the whole of the North Sea but breed at relatively few but typically large colonies. They have a prolonged breeding season with adults attending colonies from January through to November with chicks fledging from August to October. During the breeding season adults will forage up to 590 km from the breeding colony, although more typically the mean is within 100 km from the colony (Thaxter *et al* 2012). Gannets recorded in Aberdeen Bay during the breeding season are most likely to be from the colony at Troup head or potentially Bass Rock as opposed to those from Fair Isle or further afield (Lewis *et al*. 2001).

Once fledged, chicks move predominantly southwards wintering between the Bay of Biscay and Senegal. However, many gannets may also spend at least part of the winter in the North Sea. The average wintering area home range varies from between 8,100 km^2 and 308,500 km^2 (Kubetzki *et al.* 2009).

The gannet population in the UK has increased in recent decades with up to 230,000 pairs recorded during the Seabird 2000 censuses (Mitchell *et al*. 2004). In North-East Scotland the only gannet breeding colony is at Troup Head where breeding first occurred in 1986. Since then the colony has expanded and by 2007 there were 1,800 apparently occupied nests (Cutts 2011).

In North-east Scotland gannets occur throughout the year in variable numbers. Birds return to Troup Head during January and start egg laying usually during April. By October most birds have left the breeding colony (Cutts 2011). During a ten year study of seabird movements at Peterhead, gannets were scarcest during the winter, but numbers increased in the spring from April onwards, peaking in May. During the summer and early autumn numbers recorded passing Peterhead remained relatively high before decreasing from October onwards (Buckland, Bell and Picozzi 1990; Innes 1991).

Boat-based surveys

Gannets were recorded throughout Aberdeen Bay from boat-based surveys with no areas identified as being of particular importance. The majority of sightings were in water depths of between 20 m and 50 m (Appendix B). Numbers of gannets recorded were lowest between November and March and highest during the breeding season from April to August when gannets were widespread throughout the area.

Additional surveys undertaken between August 2010 and August 2011 recorded gannets in low numbers in offshore waters with clusters to the north of the Ythan Estuary and relatively few within the proposed development area (Appendix B).

Relatively few gannets were recorded from boat-based surveys during the winter months with an increase in numbers in June and a peak in July and August (Figure 4-32, to Figure 4-34).

Distance analysis of the first year's data estimated a peak density of 3.1 birds/km^2 during July within the 'control' area when none were recorded within the proposed EOWDC survey area (Figure 4-34).

Figure 4-34Additional *Distance* sampling analysis undertaken on the data collected between August 2010 and August 2011 estimated peak numbers in August, with an estimated 107 individuals and peak densities of 0.96 birds/km^2 in July to the south (Figure 4-33 and Figure 4-35).

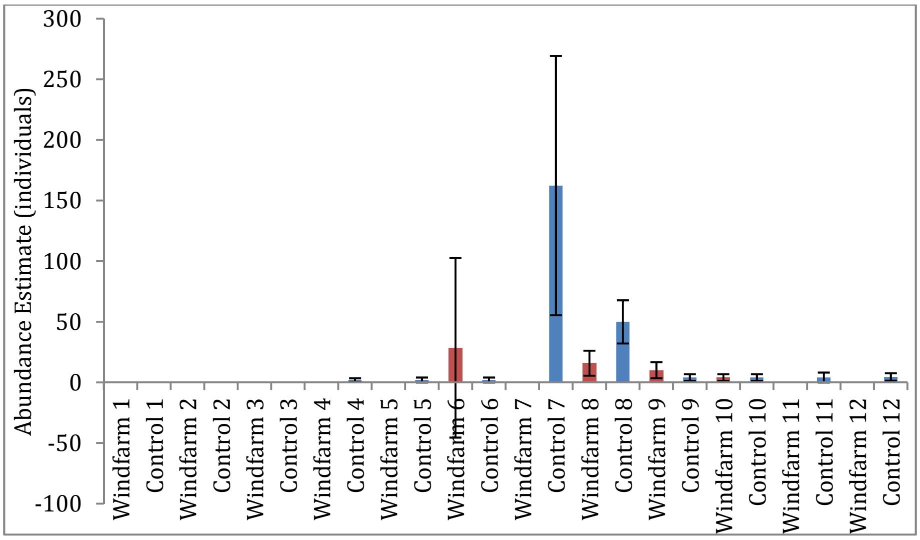


Figure 4-32: Monthly estimates (+/- SE) of abundance of gannets in the wind farm and 'control' Areas; February 2007 – January 2008 ('windfarm' 1-12 and 'control' 1-12 refers to months).

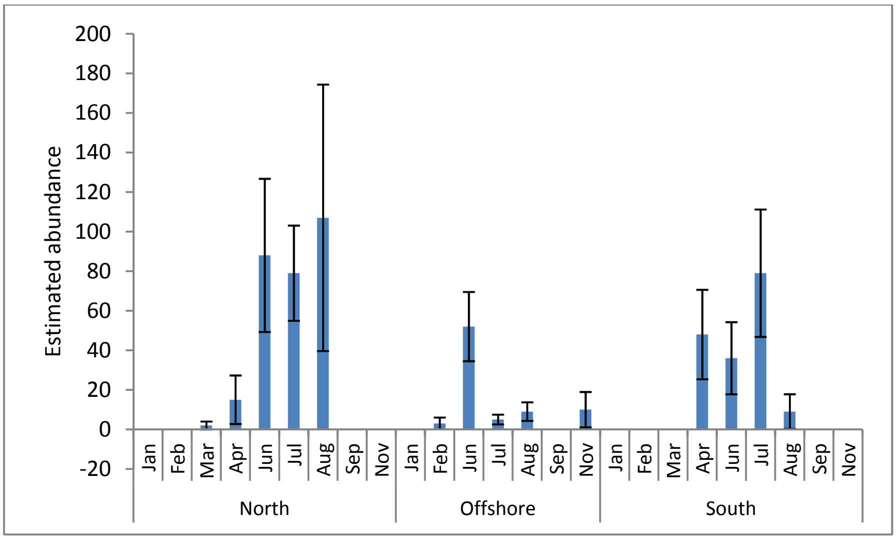


Figure 4-33: Monthly estimates (+/- SE) of abundance of gannet in the South, North and Offshore Strata between August 2010 and August 2011.

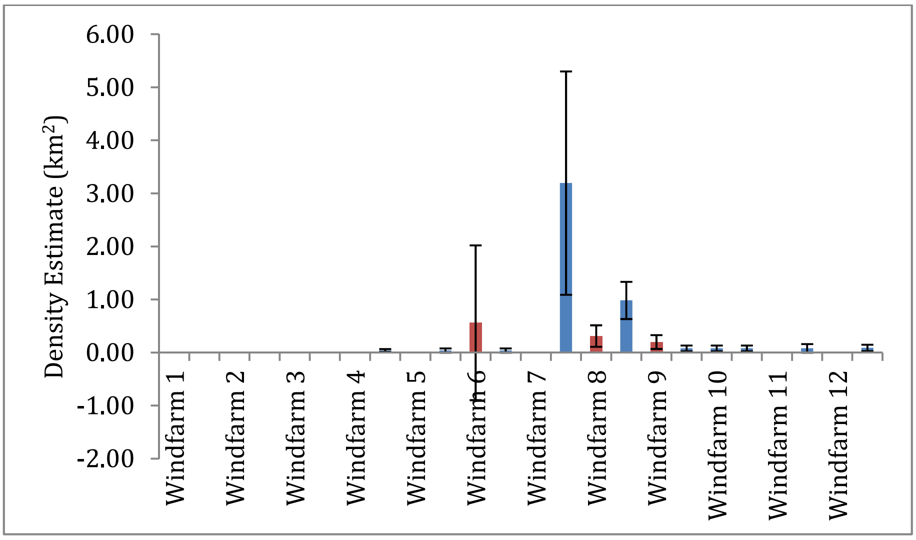


Figure 4-34: Monthly estimates (+/- SE) of density of gannets in the proposed EOWDC and 'control' Areas (wind farm 1-12 and 'control' 1-12 refers to months) – Year 1 data

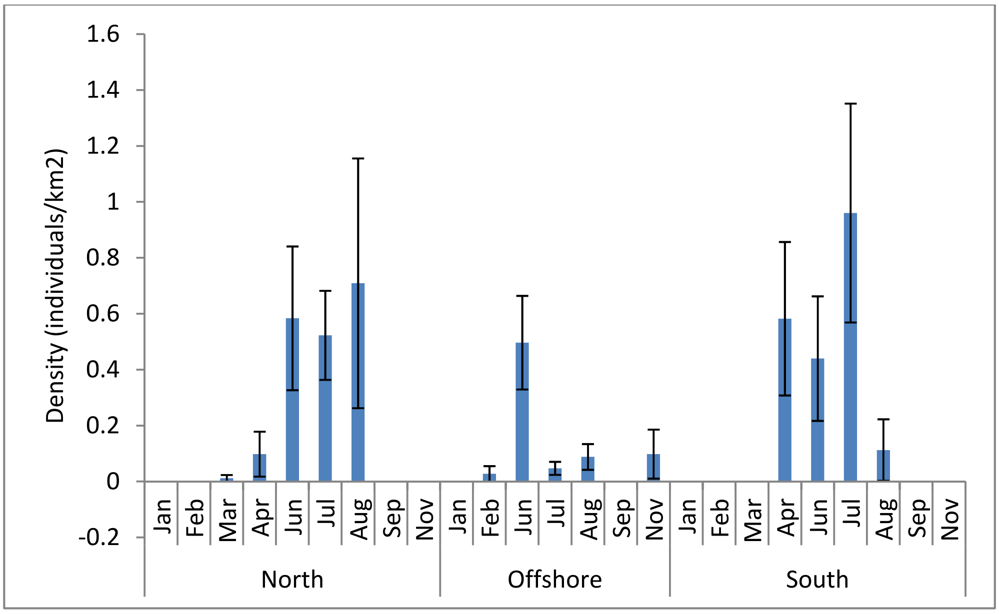


Figure 4-35: Monthly estimates (+/- SE) of density of gannet in the South, North and Offshore Strata between August 2010 and August 2011 – Year 2 data

Flight heights of gannets recorded during the boat-based surveys indicated that 68.1% of all flights were below 10 m and 7.7% were between 10 m and 25 m. 8.5% of flights were at rotor height.

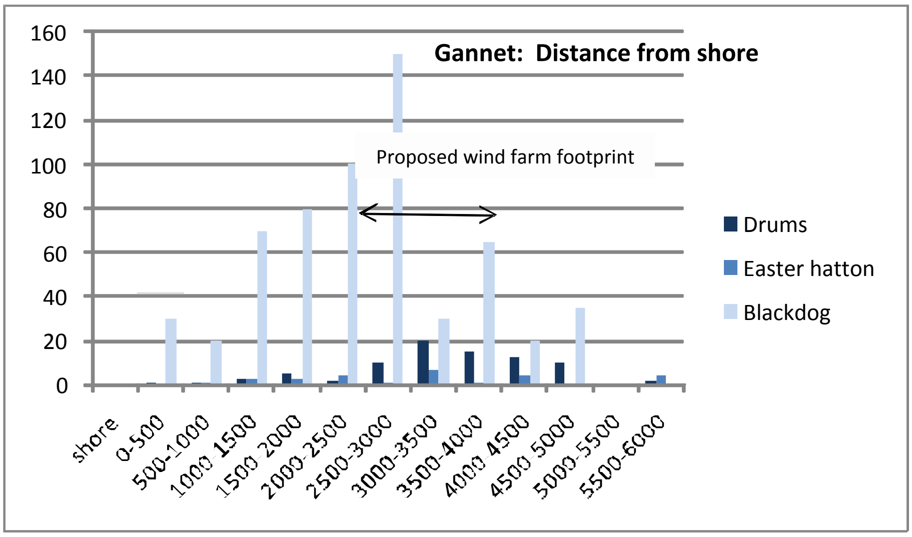
Vantage Point surveys

Gannets were observed from all vantage point sites, with a peak count of up to 120 birds per hour in July 2007 and 90 birds per hour in September 2006 (Alba Ecology 2008a, EnviroCentre 2007), which is similar to the numbers recorded at Peterhead during this time of year (Innes 1991). Numbers of gannets in Aberdeen Bay decreased after October with typically less than five birds per hour passing (EnviroCentre 2007) and typically lower numbers during the winter with less than ten birds per hour between October and March (EnviroCentre 2007; Alba Ecology 2008b).

Flight heights recorded between April and September 2006 from vantage point surveys recorded 25% of all gannets between 30–150 metre height across all vantage point Sites but between 40% and 50% were recorded within the same height bands between April to September 2007 (Alba Ecology 2008a). Gannets were recorded out to at least 3 km from shore with the majority of sightings between 2 and 3 km.

Bird Detection Radar

A total of 110 gannets were observed during the radar studies undertaken in October 2005. Sightings were of birds out to 6 km from shore, with peak numbers recorded at between 3 km and 5 km (Figure 4-36). Of those recorded in flight, the mean height was 8 m above the sea surface with a maximum height of 30 m (Walls *et al.* 2006). A total of 633 gannets were observed at a mean rate of 12.4 birds per hour at Blackdog during radar studies undertaken in April 2007. During this period the maximum flock size was of 64 birds but the mean flock size was of three (Simms *et al.* 2007). The majority of sightings were of birds flying between 1 km and 3 km offshore with a peak monthly rate of 2.9 birds per hour between 2.5 km and 3.0 km (Figure 4-36). All those recorded in flight were flying below 30 m.



(Adapted from Walls *et al.* 2006, Simms *et al.* 2007)

Figure 4-36: Distances from shore for gannet from three locations in Aberdeen Bay during surveys undertaken in October (Drums and Hatton) and April (Blackdog).

4.17.3 Summary of Results

Gannet occur throughout the year in Aberdeen Bay with peak numbers between June and August and relatively few records between November and April. Gannets were more frequently recorded within the 'control' area and to the north of the Ythan compared to the proposed development area. Results from the vantage point and radar studies suggest that the majority of gannets occur between 2–3 km offshore. Of those recorded in flight, 92% of all flights were below 25 m.

Numbers of gannet recorded in Aberdeen Bay were below the threshold for a site of national importance.

4.17.4 Species Sensitivities

Qualify species

There are two SPAs for which gannet is a qualifying species both of which may be within mean maximum foraging range from the proposed development

- Fair Isle SPA (*c*. 253 km)
- Forth Islands SPA (124.4 km).

Gannet populations at the time of designation or at the time of last review at each of the sites were:

- Fair Isle SPA held 1,166 apparently occupied nest (AoN). Recent counts indicate an increase to 3,582 AoN (2009).
- Forth Islands SPA held 21,600 pairs. Recent counts indicate an increase to 48,065 AoN (2004).

Flight height

Data obtained from boat-based surveys recorded 1,403 gannets in flight of which 8.5% were recorded flying above 25 m.

Elsewhere published data from other offshore wind farms have recorded 44,221 gannets and modelling results based on a minimum rotor blade height of 20 m predict 16% at rotor height (Cook *et al*. 2012).

Collision risk

Results from site specific monitoring indicate that gannets are widespread across Aberdeen Bay with peak numbers of passing birds between 1 km and 3 km from shore. A total of 8.5% of all sightings of flying birds were of birds flying greater than 25 m above sea surface. Consequently, gannets are at risk of collision with the proposed development.

In order to determine potential effects of collision on gannet a collision risk assessment has been undertaken (Appendix A1).

The CRM predicts between two and forty-two gannets may collide per year with the proposed development depending on the avoidance rate selected and use of site specific or generic modelled data.

Table 4-34: Gannet predicted collision mortalities per year.

Rochdale	Flight height data source	Avoidance rate (%)			
		95.0	98.0	99.0	99.5
Original	EOWDC	27 +/- 32.02	11 +/- 12.81	5 +/- 6.41	3 +/- 3.21
	Generic	50 +/- 59.07	20 +/- 23.63	10 +/- 11.82	5 +/- 5.91
Revised	EOWDC	23 +/- 26.83	9 +/- 10.74	5 +/- 5.37	2 +/- 2.68
	Generic	42 +/- 49.49	17 +/- 19.80	8 +/- 9.90	4 +/- 4.95

Flight heights of gannets are known to vary depending on behaviour, with birds foraging flying at a typically greater height than those transiting through a site. The sample size of 1,403 flight heights of gannet collected from Aberdeen Bay is considered large enough to have high degree of confidence in the results and therefore it is considered that the difference in flight heights recorded between the site specific data and the generic data may be a real difference due to behaviour and not due to a small sample size. It is possible that the majority of birds in Aberdeen Bay were not foraging but transiting through to and from foraging areas. Site specific data indicate that low numbers of gannet forage in Aberdeen Bay with 2% of gannets noted as feeding. Although this may be an underestimate as observers may not have always recorded feeding behaviour it supports the possibility that the majority of birds in Aberdeen Bay are transiting the site and therefore will be flying lower than the generic data set results which may have a larger proportion foraging and therefore at a higher flight height.

Based on more precautionary generic data and a 98% avoidance rate it is predicted that up to 17 gannets may collide at the proposed EODWC each year. During the breeding season from March to August the number predicted to collide is nine individuals.

The current SPA population in the region is 51,647 pairs.

The annual mortality rate for gannet is 8.1% (BTO 2011). Consequently, out of a population of 51,647 pairs (103,294 adults) an annual mortality of 8,367 gannets may be predicted. Therefore, 1% of the baseline mortality is 84 birds per year, i.e. an increase in mortality rate of more than 84 birds per year caused by collisions may be considered significant. For both SPA colonies current gannet populations are assessed as being favourable and maintained.

For the two individual SPAs considered, the increase in mortality that could cause an adverse effect is lower:

- Fair Isle SPA has a current population of 3,582 AoN (7,164 adults); therefore an annual mortality rate of 580 adults. 1% of baseline mortality is therefore 5 individuals.

- Forth Islands SPA has a current population of 48,065 AoN (96,130 adults); therefore an annual mortality rate of 7,786 adults. 1% of baseline mortality is therefore 78 individuals.

Tagging studies undertaken at other Shetland gannet colonies indicate a maximum foraging range during the breeding season of 150 km with most activity within 37 km (BirdLife International 2012). Although foraging ranges vary between colonies, evidence from Shetland indicates that foraging activity will likely remain within the waters around Shetland (Lewis *et al.* 2001). A recent study commissioned by The Crown Estate concludes that the UK population may be able to withstand an increase in mortality of up to 10,000 birds per year and that mortality to gannets from the distant colonies in St Kilda and Shetland will be very low (WWT *in prep*.).

It is therefore predicted that there will not be any significant impact on gannets associated with the Fair Isle SPA during the breeding season.

Tagging data of birds from the Bass Rock colony (part of the Forth Islands SPA) indicates that they forage widely and are potentially at collision risk with the proposed development (Hamer *et al.* 2000). Based on the collision risk modelling undertaken, should all the potential collisions be of birds arising from the Bass Rock colony in the Forth SPA, 124 km away, then there will be a very small increase in the baseline mortality rate and below the level that may be of concern. Population modelling undertaken for the Bass Rock gannet colony, indicates that the current population may be able to withstand an increase in mortality of up to 2,000 birds per year (WWT *in prep*.).

The regional population of gannet include a colony at Troup Head to the north of the proposed development, where a total of 1,810 AoN were counted in 2007 (JNCC 2011a). Therefore, the breeding population is 3,620 individuals and will have an annual mortality of 434 birds. The 1% baseline mortality will therefore be 4 birds per year. Based on the collision risk modelling which predicts an annual collision mortality of up to 17 birds per year it is possible that should all the gannets predicted to collide originate from the Troup Head gannetry then there is potential for an effect.

However, evidence from existing offshore wind farms indicates that gannets avoid flying through wind farms and that those that do reduce flight height to be below rotor height and therefore are not at risk of collision (e.g. Zucco *et al*. 2006; Leopold *et al*. 2011) and may have a significant far field avoidance rate (Cook *et al*. 2012). This behaviour will further reduce the risk of potential collision and it is predicted that avoidance rates for gannet are significantly greater than the 98% used in the modelling. It is also considered unlikely that all the gannets at risk of collision are from Troup Head and therefore the potential impacts to that colony will be lower.

It is predicted that the collision risk impacts will be temporally long-term and of negligible magnitude and of minor significance.

Barrier effect

Studies undertaken at Danish and Dutch offshore wind farms indicate that gannets avoid flying through operating wind farms and consequently there may be a barrier effect (Zucco *et al*. 2006; Leopold *et al.* 2011).

In order to avoid the turbines gannets may incur additional energetic expenditure. The proposed EOWDC is at its longest point approximately 4 km and at its widest 2 km. Assuming birds avoid the proposed development area at 1,000 m then they may incur an overall increase in flight distance of 3.2 km.

Gannets are extremely efficient fliers and during the breeding season can travel many hundreds of kilometres in single feeding trips up to 364 km from the colony and over 900 km in a single trip (Hamer *et al.* 2007).

The mean foraging range is approximately 100 km (Thaxter *et al.* 2012). The additional distance of up to 3.2 km an individual gannet may have to fly in order to detour around the proposed development is therefore negligible for a species that can and does forage widely. Site specific monitoring data from boat based and vantage points have not reported any regular passage or feeding locations in Aberdeen Bay. Published literature has also not reported any such behaviour (e.g. NESBR; Buckland, Bell and Picozzi 1990). Consequently, the significance of any potential impact arising from a barrier effect is temporally long-term and of negligible magnitude and significance.

Displacement

Although gannets are primarily an aerial species evidence from tracking studies indicate that they may spend up to half their time away from colonies on the sea surface and that they avoid using areas of operating wind farms (Lewis *et al*. 2001, Leopold *et al*. 2011). Consequently, gannets may be displaced from an area if they avoid entering wind farms.

Data from boat-based surveys undertaken between 2007 and 2008 and 2010 and 2011 recorded a peak count of 107 gannets in August at a density of 0.7 birds/km^2 in the proposed EOWDC survey area (SMRU 2011a); this is less than 0.1% of the SPA population. Gannet distribution was generally spread evenly across the bay with higher densities recorded to the north of the proposed development area. Site specific surveys indicate that that the area is not used extensively by gannets with low numbers reported foraging. Gannets have large foraging ranges and feed on a variety of prey items. Therefore, should there be total displacement from the area it is predicted that displaced gannets will be able to forage elsewhere. Evidence from tracking studies (e.g. Langston 2011) indicates that gannets can forage across a very wide area and that the potential loss of 4 km^2 of sea surface is very small compared to the total area in which they forage. Consequently, it is concluded that any potential impact due to displacement, should it occur, will be temporally long-term of negligible magnitude and significance.

Cumulative and in-combination

The potentially very large foraging ranges that gannets may fly suggest that any individual gannet may interact with a number of the proposed offshore wind farms in Scottish waters. Published data elsewhere indicates that gannets from colonies in Shetland or eastern England are unlikely to occur in Aberdeen Bay during the breeding season (Lewis *et al.* 2001; Langston 2011), although they may occur during periods of passage.

Consequently, there is low potential for cumulative or in-combination effects with respect to gannets from Fair Isle SPA or Bempton Cliffs SPA during the breeding season. However, there is evidence to suggest that the gannets from the Forth Island SPA may occur within the Aberdeen Bay area. Populations from this SPA may also interact with potential offshore wind farm developments currently proposed the Firth of Forth area, namely: Neart na Gaoithe, Inch Cape and Firth of Forth offshore wind farms. There is currently very limited information on the proposed developments as decisions on the location, scale and numbers of turbines are still to be published. Based on the scoping reports, it is currently predicted that there may be an additional 526 turbines within the Firth of Forth area (Table 4-35). Information on the use of these areas by gannets is limited with no published information currently available from on-going studies being undertaken for the proposed wind farms. It is therefore not possible to undertake cumulative/in-combination collision risk assessment based on collision risk modelling or an assessment on possible cumulative displacement or barrier impacts from the Firth of Forth developments.

Table 4-35: Predicted wind farms that may have an in-combination impact on gannets in the Firth of Forth.

Project	Estimated no. of turbines	Area (km^2)	Predicted Application date
Inch Cape	181	151	2012
Neart Na Gaoithe	130	105	2012
Firth of Forth (phase I)	215	597	2013

Collision risk modelling undertaken for Beatrice demonstrator project predicted a total of five gannets per year might collide based on a 98% avoidance rate (Talisman 2005). Collision risk modelling undertaken at the proposed Beatrice offshore wind farm indicates that up to 265 gannets per year may be at risk of collision based on a 98% avoidance rate and 132 per year based on a 99% avoidance rate. Up to 160 gannets are predicted to collide from the Moray Firth offshore wind farm (BOWL 2012) (Table 4-36).

Based on a population of 3,620 adults at Troup Head the potential cumulative increase of in mortality is above the 1% of baseline mortality. The gannet colony at Troup Head is increasing and therefore in a favourable condition. An increase in mortality predicted from the cumulative effects arising from the proposed EOWDC and the Beatrice offshore wind farm project has potential to cause a significant effect to the gannet colony at Troup Head. However, this is based on the assumption that all gannets at risk of collision from the proposed Moray Firth developments are from Troup Head colony.

Table 4-36: Predicted number of gannet collisions per year from proposed offshore wind farms in the Moray Firth (source BOWL 2012).

Project		Estimated no. of collisions per year	
		98%	99%
Moray Firth (phase 1)		-	160
Beatrice		265	132
EOWDC	EOWDC date	9	5
	Generic data	17	8
Total		*291+*	*305*

There is a magnitude difference in scale between the proposed development and those planned in the Firth of Forth and Moray Firth areas and it is a significantly greater distance from the Firth of Forth SPA. There is a potential for a moderate significant impact but any potential incremental increase arising from the proposed development will likely be minor by comparison.

Table 4-37: Summary of significance of potential impacts on gannet.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Medium	Negligible	Medium	Not significant
Operation	Collision	Very High	Negligible	Long-term	Minor
	Displacement	Medium	Negligible	Long-term	Not significant
	Barrier	Medium	Negligible	Long-term	Not significant
Decommissioning	Displacement	Medium	Negligible	Medium	Not significant
Cumulative	All	Very High	Medium	Long-term	Moderate

4.17.5 Conclusions

Habitats Appraisal

Based on the site specific surveys undertaken at the proposed development area, results from tagging studies undertaken and collision risk modelling it is concluded that the proposed development will not have an adverse effect on gannets as qualifying species for Fair Isle SPA or Forth Islands SPA. There is the potential for an in-combination impact with other proposed offshore wind farms.

Environmental Impact Assessment

Based on the site specific data and the known behaviour of gannets it is predicted that there will not be a significant environmental effect arising from the proposed development on gannets. However, there is the potential for a cumulative impact with gannets associated with other proposed offshore wind farms.

4.18 Manx shearwater (*Puffinus puffinus*)

4.18.1 Protection and Conservation Status

The Manx shearwater is listed in Appendix II of the Bern Convention, and is on the Amber List of Species of Conservation Concern.

4.18.2 Background

Manx shearwater		
GB Population	277,803 – 374,000 prs.	Mitchell *et al* 2004
International threshold	Unknown	-
GB threshold	5,400 ind.	1% of GB Pop[n]
Designated east coast sites where species is a noted feature	None	JNCC
European population estimate	Breeding 350,000 – 390,000 Wintering – unknown	Birdlife 2004
European population trend	Status 'localised' Trend 'unknown'	Birdlife 2004
World population	340,000 – 410,000 ind.	JNCC 2011

Most of the world population of Manx shearwaters breed in Britain and Ireland. The world population is estimated to be between 338,000 and 411,000 pairs of which up to 374,000 pairs nest in Britain and Ireland (Mitchell *et al.* 2004).

There are no breeding colonies in the North Sea but outwith the breeding season Manx shearwaters disperse widely and migrate south to winter in waters off South America (Wernham *et al*. 2002).

In North-east Scotland Manx shearwaters occur in relatively low numbers from late spring through to the autumn (NESBR). Studies undertaken off Peterhead identified a passage of Manx shearwaters from April through to November with peak numbers passing in June and July with up to ten birds per hour. The number of birds passing varies considerably with the majority of sightings occurring in periods of rain or sea mist and fewer records during periods of bright fine weather (Innes 1992).

Boat-based surveys

A total of 118 Manx shearwaters were recorded from all boat-based surveys between April and November, with sightings scattered across Aberdeen Bay (Appendix B). Peak numbers occurred during June (Figure 4-37). Nearly ninety percent of all records were of birds in flight with the majority heading north.

Flight height data collected from boat-based surveys recorded 100% of all flights as below 25 m.

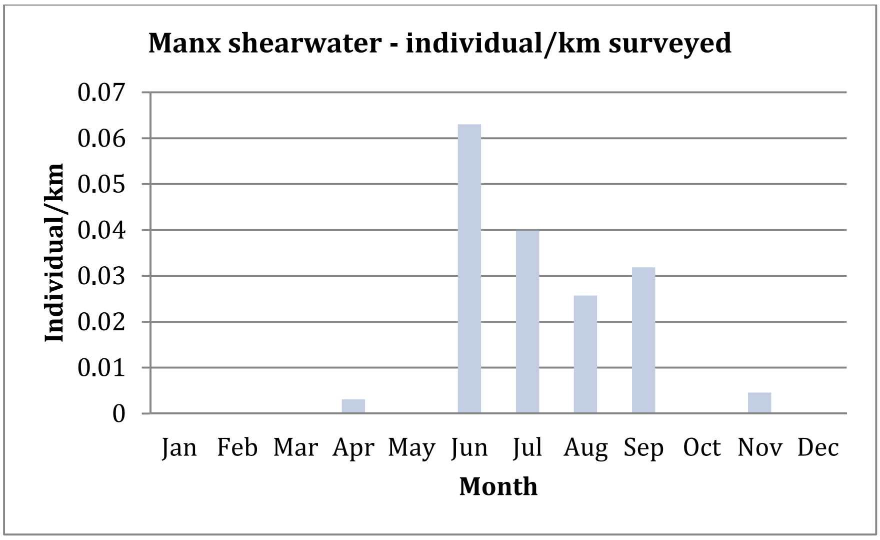


Figure 4-37: Relative abundance of Manx shearwater in Aberdeen Bay from boat-based surveys.

Vantage Point surveys

Manx shearwaters were observed in Aberdeen Bay from vantage point surveys between April and November with a peak of up to five birds per hour during June 2006. (EnviroCentre 2007; Alba Ecology 2008a, b).

Bird Detection Radar

There were five sightings of Manx shearwaters during the seventeen days of observations undertaken in April 2007 (Simms *et al.* 2007).

4.18.3 Summary of Results

Manx shearwaters were recorded in low numbers from between April and November with a peak in June. Of those recorded in flight from boat-based surveys all flights were below 25 m and most sightings were of birds approximately 1 km from shore.

Numbers of Manx shearwaters recorded in Aberdeen Bay were below the threshold for a site of national importance.

4.18.4 Species Sensitivities

Qualifying species

There are no SPAs in the North Sea for which Manx shearwater is a qualifying species. Of the four UK SPAs for which Manx shearwater is a qualifying species, two are in Wales and the other two are off western Scotland.

Flight height

Of those recorded in flight and for which flight heights were recorded, all Manx shearwaters were flying below 25 m.

Elsewhere, data from other offshore wind farms have recorded all Manx shearwater as flying below turbine height. Data from Walney offshore wind farm reported 5,999 sightings of which 99% were flying below 5 m (DONG 2006).

Collision risk

Evidence from site specific monitoring and elsewhere indicates that Manx shearwaters rarely fly at turbine height and are therefore not at risk of collision (Dong 2006). The potential effect is temporally long-term and of negligible magnitude and significance.

Barrier effect

The number of Manx shearwaters reported at operating wind farms is very low consequently there is little or no evidence of any barrier effect.

Should a barrier effect occur then Manx shearwaters will fly around the proposed development. This would incur an overall increase in flying distance of approximately 3.2 km. Manx shearwaters are a highly pelagic species spending a significant proportion of their time in flight and travelling large distances. Foraging ranges for breeding birds are up to 330 km from their colonies (Guilford *et al.* 2008). The additional energetic cost that may be incurred if a barrier effect occurs will be temporally long-term and of negligible magnitude and not have any significant impact on Manx shearwaters.

Displacement

Relatively few Manx shearwaters were recorded from either the boat-based or the land-based surveys. Of those recorded nearly 90% were of birds in flight, indicating that Aberdeen Bay is not used regularly as an area for birds to settle on the sea surface.

There are currently no constructed wind farms anywhere in the world where Manx shearwater regularly occur from which conclusions can be drawn to assess whether or not there may be a displacement effect. However, the relatively low usage of Aberdeen Bay by Manx shearwaters and the observation that approximately 90% of Manx shearwaters recorded were only in flight indicates that there will not be a significant impact should displacement occur and the significance of any potential impact will be temporally long-term and of negligible magnitude or significance.

Cumulative and in-combination

The very low level of usage of the site by Manx shearwater indicates that there will not be any cumulative or in-combination impacts.

Table 4-38: Summary of significance of impacts on Manx shearwater.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Low	Negligible	Medium	Negligible
Operation	Collision	High	Negligible	Long-term	Negligible
	Displacement	Low	Negligible	Long-term	Negligible
	Barrier	Low	Negligible	Long-term	Negligible
Decommissioning	Displacement	Low	Negligible	Medium	Negligible
Cumulative	All	Low	Negligible	Long-term	Negligible

4.18.5 Conclusions

Habitats Appraisal

There are no SPAs for which Manx shearwater is a qualifying species that will be adversely affected by the proposed development.

Environmental Impact Assessment

Based on the relatively low numbers of Manx shearwaters recorded and their known behaviour it is predicted that there will not be a significant environmental effect arising from the proposed development on Manx shearwaters.

4.19 Great cormorant (*Phalacrocorax carbo*)

4.19.1 Protection and Conservation Status

The (great) cormorant is listed in Annex III of the Bern Convention and is on the Green List of Species of Conservation Concern.

4.19.2 Background

Cormorant		
GB population	Breeding: 8,400 prs. Winter: 23,000 ind.	BTO 2011
Scottish population	Breeding: 3,600 AoN Winter: 9,000 – 11,000 ind.	Forrester *et al.* 2007
International threshold	1,200 ind.	Calbrade *et al.* 2010
GB threshold	230 ind.	Calbrade *et al.* 2010
Designated east coast sites where species is a noted feature	Forth Islands: 198 prs. Firth of Forth: wintering assemblage Firth of Tay and Eden Estuary: wintering assemblage	SNH 2011b JNCC 2011a
European population estimate	Breeding: 310 – 370,000 prs. Wintering: unknown	Birdlife 2004
European population trend	Status 'secure' Trend 'large increase'	Birdlife 2004
World population	1,4 – 2,900,000 ind.	Birdlife 2011

Cormorants occur widely across the UK breeding and wintering on both freshwater bodies inland and also at coastal locations. Breeding occurs in colonies from April through to September when coastal breeding birds remain largely within nearshore waters. Following breeding, there is some dispersal away from the breeding areas with many birds moving south during the winter. The population of cormorant has increased across the whole of the UK but has decreased in certain localised areas. In North-east Scotland cormorants used to be a scarce breeding species. However, since 2000 a number of new colonies have formed at Hackley Bay at the north of Aberdeen Bay and at Inverbervie, to the south of Aberdeen. At least 80 pairs nest at these two colonies and overall approximately 300 pairs nest in the region (Duncan 2011b).

Results from ten years of observations undertaken at Peterhead indicate strong seasonal differences with peak numbers of cormorant occurring during the autumn and winter and relatively low numbers between May and August. Peak counts of up to 20 birds per hour were recorded in October with the majority of sightings shortly after dawn. Nearly all observations were within 500 metres of the coast (Innes 1991). Elsewhere cormorants occur widely along the coast with up 150 birds being recorded on the Ythan Estuary (NESBR).

Boat-based surveys

During Year 1 boat-based surveys, cormorants were recorded in low numbers throughout the year. With the exception of one record of 25 birds, nearly all sightings were of single birds in nearshore waters and in water depths of less than 20 m. Concentrations of cormorant were recorded in the shallow waters between the Ythan Estuary to Collieston (Appendix B) (IECS 2008). A peak of 0.3 cormorant per km surveyed occurred during October although peak densities of 0.61 birds/km^2 were recorded in the control area during the spring compared to none during the same period within the proposed EOWDC location (Table 4-39).

Data collected between August 2010 and August 2011 recorded lower densities during the spring compared to the Year 1 surveys with peak numbers of cormorants during September and October (Figure 4-38, SMRU 2011b).

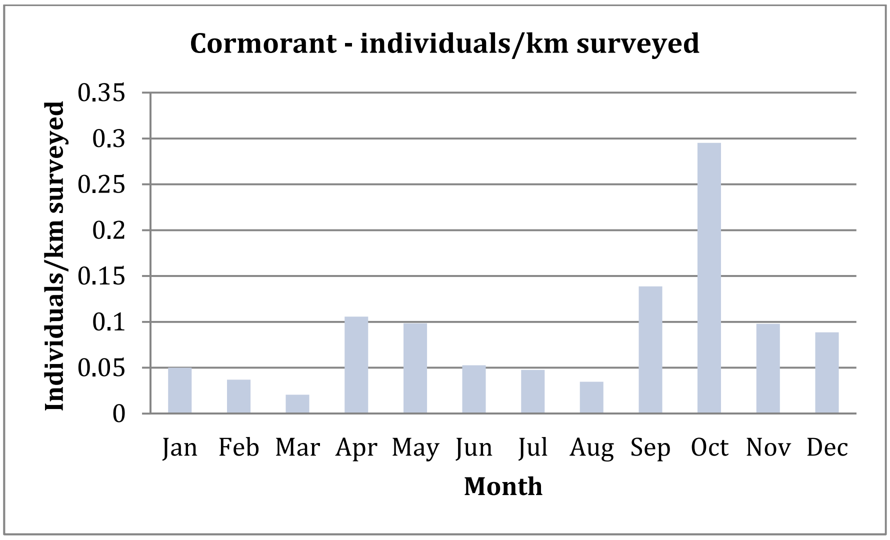


Figure 4-38: Encounter rates of cormorant in Aberdeen Bay from two years of boat-based surveys.

There were not enough records from the Year 1 boat-based surveys to undertake *Distance* sampling on a monthly basis. However, *Distance* sampling was possible on seasonal data. Peak overall estimated abundances were during the spring and autumn periods with the majority of sightings within the 'control' area. Throughout the year, the numbers of cormorant estimated to be in the 'control' area were higher than within the proposed EOWDC area.

Table 4-39: Seasonal estimates of density and abundance of cormorants in the proposed EOWDC and 'control' areas – Year 2 (August 2010 to August 2011).

	Density Estimate (km^2)	SE	Estimated Abundance	SE	No. Observations
EOWDC- Spring	0.000	0.000	0	0.0	0
Control- Spring	0.616	0.221	31	11.2	24
EOWDC- Summer	0.039	0.040	2	2.0	1
Control- Summer	0.358	0.223	18	11.3	9
EOWDC- Autumn	0.348	0.180	18	9.1	6
Control- Autumn	0.472	0.200	24	10.1	10
EOWDC- Winter	0.177	0.075	9	3.8	6
Control- Winter	0.268	0.134	14	6.8	9

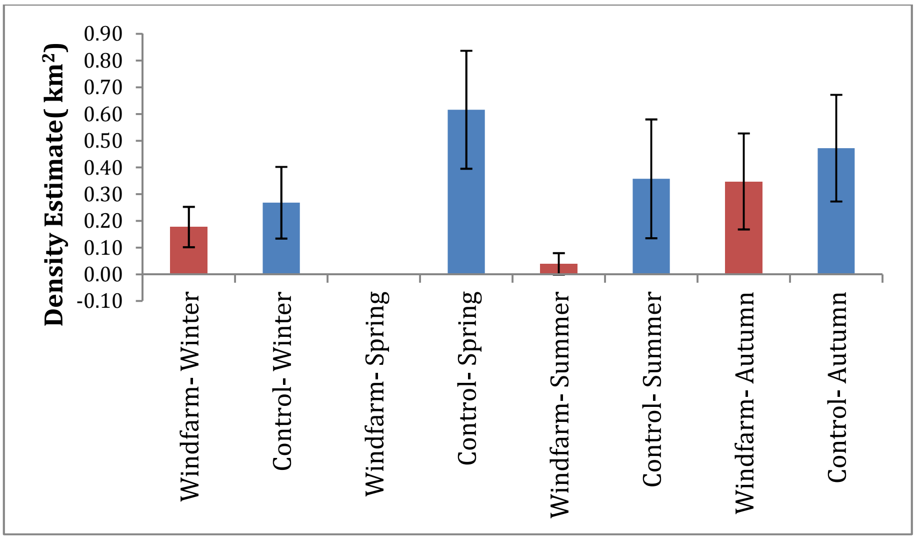


Figure 4-39: Seasonal estimates (+/- SE) of density of cormorants in the proposed EOWDC and 'control' Areas – Year 2 (August 2010 to August 2011).

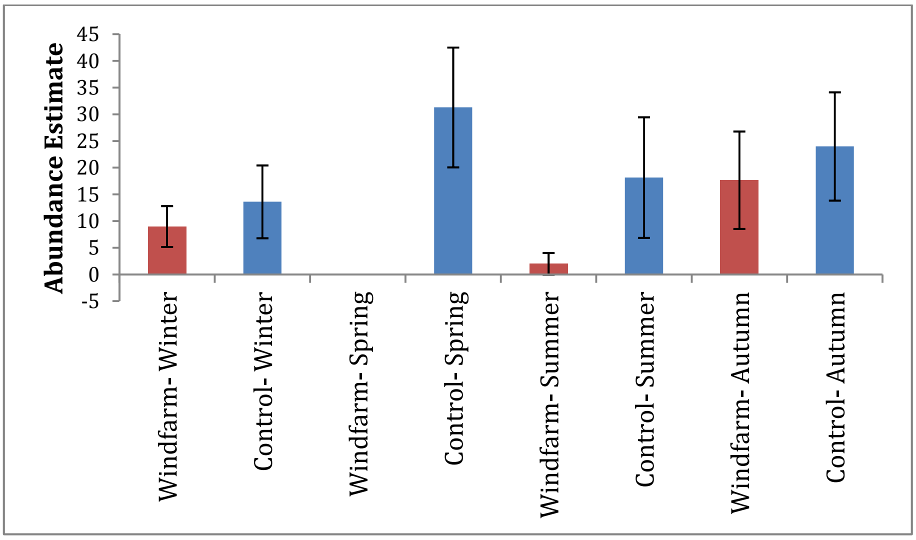


Figure 4-40: Seasonal estimates (+/- SE) of abundance of cormorants in the proposed EOWDC and 'control' Areas – Year 2 (August 2010 to August 2011).

Results from Year 2 (2010 and 2011) boat-based survey data indicated the presence of cormorants within the survey area at relatively low numbers with not enough data to undertake Distance sampling on a monthly basis. However, as with the Year 1 data, Distance sampling was able to be undertaken on a seasonal basis the results from which indicated peak numbers in the autumn and reduced densities in the winter (Table 4-40).

Table 4-40: Density, and abundance estimates for cormorant per study strata and per season – Year 2 (August 2010 to August 2011).

Strata	Month	Density estimate	% CV	Abundance estimate	% CV
North	Spring	0.02	3	3	72.6
	Summer	0.07	11	11	39.74
	Autumn	0.18	27	27	41.72
	Winter	0.02	4	4	108.67
Offshore	Spring	0.00	0	0	0
	Summer	0.00	0	0	0
	Autumn	0.00	0	0	0
	Winter	0.00	0	0	0
South	Spring	0.00	0	0	0
	Summer	0.01	103.51	1	103.51
	Autumn	0.00	0	0	0
	Winter	0.03	99.65	2	99.65

Vantage Point surveys

Cormorants were present during peak dawn and dusk activity periods in Aberdeen Bay throughout the year with peak numbers between June and September. Up to 15 birds per hour passed during peak periods. During the winter months the number of cormorants within Aberdeen Bay was lower with less than five birds per hour passing any one vantage point (EnviroCentre 2007). Of those recorded in flight, 8% of cormorants were flying between 30 m and 150 m above sea surface with 0.5 birds per hour doing so during the winter months and up to one per hour during summer months (EnviroCentre 2007). The majority of sightings were within 2 km of the coast (Alba Ecology 2008b).

Bird Detection Radar

Observations made during radar studies during October 2005 recorded A total of 96 cormorants. The number of observations made between the two sites from which the surveys were undertaken was similar, with 47 cormorants recorded at Drums and 49 at Easter Hatton (Walls *et al*. 2006). Forty-three cormorants were recorded off Blackdog over a seventeen day period in April 2007. Most sightings were of single birds but a flock of three was recorded (Simms *et al.* 2007).

4.19.3 Summary of Results

Cormorants were regularly recorded in Aberdeen Bay throughout the year. Peak numbers occurred in the spring and autumn with most sightings within the 'control' area. Peak abundance of 31 birds and a density of 0.61 birds/km^2 occurred in the 'control' area during the spring. The majority of sightings were within 2 km of the coast and of those recorded in flight, 85% of all flights were below 30 m.

Numbers of cormorant recorded in Aberdeen Bay were below the threshold for a site of national importance.

4.19.4 Species Sensitivities

Qualifying species

The nearest SPA to the proposed development for which cormorant is a qualifying breeding species is the Forth Islands SPA. The cormorant is also a qualifying species for the Firth of Forth SPA and Firth of Tay and Eden Estuary SPA for which the species is listed under Article 4.2 as part of wintering waterfowl assemblage (SNH 2011b).

Flight height

Of those recorded in flight from boat-based surveys and for which flight heights were recorded, 98.2% were flying below 25 m and 1.8% at rotor height. Data obtained from vantage point counts indicated that 8% were flying between 30 m and 150 m. There are no data on flight heights of cormorant available from Cook *et al.* (2012) report.

Collision risk

Results from site specific monitoring indicate that cormorants are widespread in nearshore waters across Aberdeen Bay (Appendix B).

In order to determine potential effects of collision on cormorant a collision risk assessment has been undertaken (Appendix A1).

The CRM predicts less than one cormorant may collide with the proposed development per year (Table 4-21).

Table 4-41: Cormorant predicted collision mortalities per year.

Rochdale	Flight height data source	Avoidance rate (%)			
		95.0	98.0	99.0	99.5
Original	EOWDC	0 +/- 0.50	0 +/- 0.20	0 +/- 0.10	0 +/- 0.05
Revised	EOWDC	0 +/- 0.42	0 +/- 0.17	0 +/- 0.08	0 +/- 0.0

Based on the precautionary avoidance rate of 98% it is predicted that there will be less than one collision per year.

The annual mortality rate for cormorant is 12% (BTO 2011). Consequently, out of a population of 198 pairs (396 individuals) at the Forth Islands SPA an annual mortality of 47 cormorants may be predicted. Therefore, 1% of the baseline mortality is 0.5 birds per year.

Cormorants associated with the non-breeding wintering assemblages at the Firth of Forth and Firth of Tay and Eden Estuary SPA will likely remain largely within or in the vicinity of those sites during the non-breeding seasons. Both sites are in excess of 90 km away from the proposed development and therefore not at risk of an adverse effect from the proposed development.

Within North-east Scotland cormorants breed to the north of the proposed development with colonies on the Forvie National Nature reserve (NNR), Boddam area and Loch of Strathbeg. The majority of birds recorded from boat-based and land-based surveys were recorded in the 'control' area to the north and therefore are likely to be birds associated with these colonies. Based on an estimated breeding population of 300 pairs (600 individuals) an increase in mortality of 0.6 birds per year could be significant.

Results from collision risk modelling indicate that the risk of collision is very low, with less than one collision per year. Evidence from existing wind farms indicate that cormorants take avoidance behaviour and that up to 43% will do so before being at risk of collision (Cook *et al* 2011). Furthermore studies undertaken at Ronland Offshore wind farm in Denmark recorded only one observation of cormorant at risk of collision after 560 hours of observations (Jensen 2006). Data from Sweden also indicates a significant reduction in the number of cormorants flying through the wind farm site once in operation compared to pre-construction (Zucco *et al.* 2006).

Based on the site specific data, results from collision risk modelling and monitoring results from constructed offshore wind farms, it is concluded that risk of a significant environmental impact is temporally long-term and of negligible magnitude and of minor significance.

Barrier effect

Although cormorants are regularly recorded within operating wind farms there is also evidence of a barrier effect with birds detouring around turbines (Petersen *et al*. 2006).

Should a barrier effect occur then cormorants will fly around the proposed development. By doing so, this could cause an overall increase in flying distance of up to approximately 3.2 km. For a bird foraging at the maximum recorded foraging range from a colony of 35 km this additional distance would equate to an additional 10% of flight distance and add between 1% and 2% to the daily energy expenditure (Speakman, Gray and Furness 2009).

Foraging ranges of up to 35 km have been reported as unusual with only 5% of flights being of that distance and typical foraging range being of 5 km or less (Thaxter *et al.* 2012; Roos 2010). The additional 1 – 2% of daily energy expenditure that could be incurred by avoiding the proposed development area will not on an *ad hoc* basis have a significant effect and as foraging flights of that distance are unusual and not predicted to take place on a daily basis there will not be any detrimental cumulative impact caused by regular flights around the proposed development. Based on the evidence from existing offshore wind farms and site specific data it is concluded that the potential barrier effect will have a temporally long-term impact of low magnitude but of negligible significance.

Displacement

Although cormorants may fly around wind farms they have also been regularly recorded within constructed offshore wind farms where they use the turbine structures for perches and have been recorded feeding within arrays of wind turbines (Petersen 2004). Consequently, although there may be a minor effect to flying birds, cormorants do occur within wind farms and there is not total displacement and it is predicted that the impacts will be negligible in magnitude and of minor significance and there will not be a significant effect arising from the proposed development on cormorants from displacement effects.

Cumulative and in-combination

The three closest SPAs for which cormorant is a qualifying species are all over 90 km away. The proposed offshore wind farms within the Firth of Forth area or the Moray Firth are all in waters largely in excess of 20 m water depth and therefore in areas where cormorants are unlikely to regularly occur. For example, only two cormorants were recorded over a year of surveys at the Beatrice Offshore wind farm demonstrator project and two birds over two years of surveys for the proposed Beatrice offshore wind farm (BOWL 2012; Talisman 2005). Any impacts, should they occur, will be negligible in magnitude and of minor significance. It is therefore predicted that there will not be an adverse or significant effect on cormorants from either the proposed development on its own or in combination with other plans or programmes.

Table 4-42: Summary of significance of impacts on cormorant.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Very High	Negligible	Medium	Minor
Operation	Collision	Very High	Negligible	Long-term	Minor
	Displacement	Very High	Negligible	Long-term	Minor
	Barrier	Medium	Low	Long-term	Negligible
Decommissioning	Displacement	Very High	Negligible	Medium	Minor
Cumulative	All	Very High	Negligible	Long-term	Minor

4.19.5 Conclusions

Habitats Appraisal

There are no SPAs for which cormorant is a qualifying species that will be adversely affected by the proposed development.

Environmental Impact Assessment

Based on the site specific data and data from existing offshore wind farms it is predicted that there will not be a significant environmental effect arising from the proposed development on cormorants.

4.20 European shag (*Phalacrocorax aristotelis*)

4.20.1 Protection and Conservation Status

The (European) shag is included in Annex I of the Wild Birds Directive and Annex II of the Bern Convention. It is also included on the Amber List of Species of Conservation Concern.

4.20.2 Background

Shag		
GB Population	Summer: 27,000 prs.	BTO 2011
Scottish population	Summer: 21,500 – 30,000 prs. Winter: 60,000 – 80,000 ind.	Forrester *et al.* 2007
International threshold	2,000 ind.	Calbrade *et al.* 2010
GB threshold	540 ind.	1% of GB population
Designated east coast sites where species is a noted feature	Buchan Ness to Collieston Coast: 344 prs. Forth Islands: 480 prs.	SNH 2011b JNCC 2011a
European population estimate	Breeding 75,000 – 81,000 pairs Wintering – >92,000	Birdlife 2004
European population trend	Status 'secure' Trend 'moderate decline'	Birdlife 2004
World population	230 – 240,000 'adults'	Birdlife 2011

The (European) shag occurs widely along rocky coastal areas of the UK where they breed in loose colonies along suitable rocky shores and forage typically within approximately 4 km of the shore. Outwith the breeding season, shags disperse locally usually less than 100 km away from their breeding colonies. Birds from the Isle of May have been recorded within North-east Scotland (BTO 2012; GRG 2012). They remain within nearshore coastal waters often around rocky coasts or in large shallow sandy bays feeding, primarily, on a variety of fish species. The breeding population in the UK has increased substantially during the 20th century from 34,000 pairs in 1969/1970 to 43,000 pairs in 1985-1988.

In North-east Scotland, shags occur widely along all coasts. The breeding population in the region increased during the 20th century, with a 35% increase between 1981/84 and 2002/06. The current population is estimated to be between 730 and 1,000 pairs (Innes 2011).

Regular daily movements to and from roosting sites have been recorded at Peterhead. Peak counts at Peterhead occurred from October through to March where up to 1,200 birds per hour have been recorded flying north at dawn and counts of 3,000 to 4,000 birds have been recorded (Buckland, Bell and Picozzi 1990). During the breeding season the numbers of birds at Peterhead were considerably lower with less than 200 birds per hour passing (Innes 1991).

Boat-based surveys

In Year 1 only fourteen shags were recorded 'in transect' during boat-based surveys with all but one within approximately 3 km of the coast and in water depths of less than 20 m. Records of birds detected but not in transect are included presented in Appendix B and indicate that occasional records may occur further offshore.

Data collected in Year 2 also indicated that shags remain largely within coastal waters with few sightings more than 3 km offshore and none within the proposed EOWDC Appendix B.

There were two shags recorded during the breeding season within the proposed EOWDC development area during Year 1 and none in Year 2. The majority of sightings were recorded to the south (Appendix B).

Distance sampling undertaken on a monthly basis indicate peak abundance and density occur during March and April and July and August. Peak numbers in the spring occurred in the north strata whereas those in the autumn occurred to the south of the proposed development area (Figure 4-41 and Figure 4-42)

The abundance and density figures for March are due to the Distance sampling techniques as they are almost twice the size of the world population.

Encounter rates based on Year 1 and Year 2 data combined indicate that peak numbers of shags occur in Aberdeen Bay between July and November with relatively few shags encountered during the winter and spring (Figure 4-43).

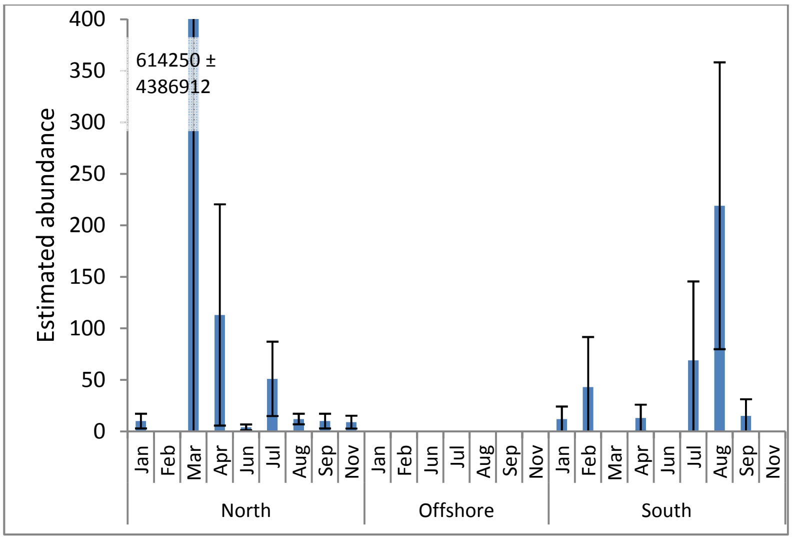


Figure 4-41: Monthly abundance estimates for shag in each study strata.

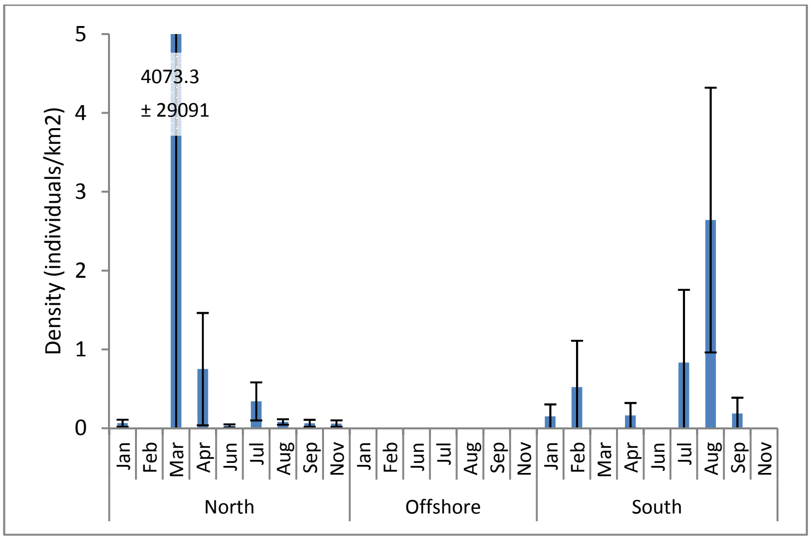


Figure 4-42: Monthly density estimates for shags in Aberdeen Bay in each study strata.

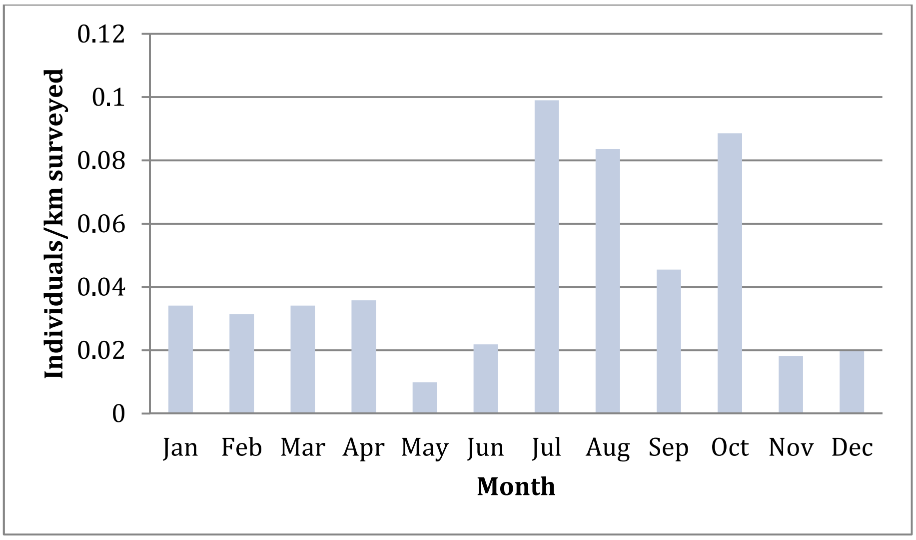


Figure 4-43: Encounter rates of shags in Aberdeen Bay from boat-based surveys.

Vantage Point surveys

In Aberdeen Bay shags were recorded in low numbers throughout the year. Peak numbers occurred in April with three birds per hour during April 2006 and eight birds per hour in April 2007 (EnviroCentre 2007; Alba Ecology 2008a). Numbers decreased to less than one bird per hour during the winter months (EnviroCentre 2007, Alba Ecology 2008b). Most shags were recorded between 1 km and 3 km from shore and at least 93% were flying below 30 m (EnviroCentre 2007).

Bird Detection Radar

One shag was recorded at Easter Hatton during the five days of observations undertaken at both Drums and Easter Hatton in October 2005 (Walls *et al*. 2006). A further 14 birds were recorded during the 17 days of surveys undertaken in April 2007 (Simms *et al.* 2007).

4.20.3 Summary of Results

Although shags were recorded regularly in Aberdeen Bay throughout the year numbers were generally low. Peak numbers occurred in the autumn with most sightings within 2 km from the shore.

Numbers of shag recorded in Aberdeen Bay were below the threshold for a site of national importance.

4.20.4 Species Sensitivities

Qualifying species

The shag is a qualifying species for Buchan Ness to Collieston Coast SPA which lies approximately 9.5 km to the north of the proposed development and also the Forth Islands SPA which lies approximately 124 km to the south of the proposed development (SNH 2011b).

Flight height

Of those recorded in flight from boat-based surveys and for which flight heights were recorded all shags were flying below 25 m.

Modelling results from other offshore wind farms based on a minimum rotor blade height of 20 m predict 13% of shags as flying at rotor height (n=233) (Cook *et al*. 2012).

Collision risk

Results from site specific monitoring indicate that shags are uncommon within the area of the proposed development. All sightings from boat-based surveys were of birds flying below rotor height and therefore not at risk from collision with the turbines. Further evidence from other offshore wind farms further indicates that shags flying at rotor height are unusual (e.g. ERM 2005).

In order to determine potential effects of collision on shags a collision risk assessment has been undertaken (Appendix A1).

The CRM predicts between zero and one shag per year may be at risk (Table 4-43 and Table 4-21).

Table 4-43: Shag predicted collision mortalities per year.

Rochdale	Flight height data source	Avoidance rate (%)			
		95.0	98.0	99.0	99.5
Original	EOWDC	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00
	Generic	0 +/- 0.22	0 +/- 0.09	0 +/- 0.04	0 +/- 0.02
Revised	EOWDC	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00
	Generic	2 +/- 2.25	1 +/- 0.90	0 +/- 0.45	0 +/- 0.22

Based on the precautionary avoidance rate of 98% it is predicted that there will be no more than one collision per year.

The current population of shags at the nearest SPA, Buchan Ness to Collieston Coast is 344 pairs, 688 individuals and the population is reported to be in unfavourable but stable condition (SNH 2011b). The population reported at the time of designation in 1998 was 1,045 pairs (SNH 2011b) and the population has therefore decreased by 701 pairs over ten years, an average of 140 birds a year. However, this apparent decrease is based on a cited population level at the Buchan Ness to Collieston Coast SPA greater than the whole of the Aberdeenshire population either past or present and no reports of a population decline have been recorded elsewhere (Innes 2011).

Based on the relatively low numbers of shags recorded within the area of the proposed development and evidence indicating that shags rarely fly at rotor height it is predicted that very few collisions will occur and any impacts will be temporally long-term, of negligible magnitude and of minor significance, and will not cause an adverse effect on shag as qualifying species for either the Buchan Ness to Collieston Coast SPA or the Forth Islands SPA.

Barrier effect

There is little or no evidence from existing offshore wind farms to determine whether or not a barrier effect may occur. However, should it do so then shags will fly around the proposed development. By doing so, this could cause an overall increase in flying distance of up to approximately 3.2 km. For a bird foraging at the maximum recorded foraging range from a colony of 17 km (Thaxter *et al*. 2012) this additional distance would equate to an additional 18% of flight distance and add between 1% and 2% to the daily energy expenditure (Speakman, Gray and Furness 2009). The impact that an increase in energetic expenditure may have depends on the individual's fitness.

Foraging ranges of up to 17 km are unusual and mean foraging ranges are less than 7 km from the colony (BirdLife International 2012; Thaxter *et al*. 2012). Consequently, the majority of foraging being undertaken by shags associated with the SPAs will be outwith the proposed development area and there will not be a barrier effect. The additional 1% to 2% of daily energy expenditure that may be incurred on the occasions that shags do forage further and maybe avoid the proposed EOWDC area, will not on an *ad hoc* basis have a significant effect. Boat-based survey data indicates that shags do not occur in the proposed development area nor further offshore. Therefore, flights of that distance across the proposed development area are predicted to be infrequent and there will not be any detrimental cumulative impact caused by regular flights around the proposed development. Based on the evidence from existing offshore wind farms and site-specific data it is concluded that the potential barrier effect will be temporally long-term and of negligible magnitude and significance.

Displacement

There are limited data from existing offshore wind farms that shags do occur within operating wind farms (Christensen and Hounisen 2005). However, should displacement occur then an area of approximately 4 km^2 might not be utilised by shags. Data from boat-based surveys indicate that shags are relatively uncommon within the vicinity of the proposed development and that the area is not an important location for shags with highest densities recorded to the north and south. Should displacement occur the number of birds potentially displaced would be relatively small based on the peak density recorded from any of the surveyed areas of 2.6 birds/km^2. The displacement of a relatively small number of shags into other wider areas where they are known to occur will not have a detrimental effect. Based on the results from site specific surveys it is predicted that potential impacts will be temporally long-term and of negligible magnitude and minor significance and there will not be any significant environmental or adverse effects on shags from displacement impacts.

Cumulative and in-combination

Of the two SPAs for which shag is a qualifying species: the Forth Islands SPA is 124 km away and will not be impacted by the proposed development and the Buchan Ness to Collieston Coast SPA is 9.5 km away. No adverse effects are predicted upon either of these sites from the proposed development on its own. The proposed offshore wind farms within the Firth of Forth area and the Moray Firth are in deeper waters but may still be in areas where shags can forage. No data are available as to whether shags are being recorded at the Firth of Forth developments. However, the distance from shore for all the planned Round 3 and Scottish Territorial Water wind farms locations indicate that they are unlikely to be frequently used as areas of importance for shags. The Beatrice demonstrator project recorded 63 shags over a 12 month period and 41 over two years of surveys for the proposed Beatrice offshore wind farm indicating that the area is not extensively used by this species (BOWL 2012; Talisman 2005).

Based on the data available it is predicted that any possible impacts on shags in combination with other plans or programmes will of negligible magnitude of minor significance.

Table 4-44: Summary of significance of potential impacts on shag.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Very High	Negligible	Medium	Minor
Operation	Collision	Very High	Negligible	Long-term	Minor
	Displacement	Very High	Negligible	Long-term	Minor
	Barrier	Medium	Negligible	Long-term	Negligible
Decommissioning	Displacement	Very High	Negligible	Medium	Minor
Cumulative	All	Very High	Negligible	Long-term	Minor

4.20.5 Conclusions

Habitats Appraisal

Based on the results from site specific surveys undertaken at the proposed development area, in particular the relatively low usage of the site along with evidence from existing wind farms, it is concluded that the proposed development will not have an adverse effect on shags as qualifying features for Buchan Ness to Collieston SPA.

Environmental Impact Assessment

Based on the site specific data and data from existing offshore wind farms it is predicted that there will not be a significant environmental effect arising from the proposed development on shags.

4.21 Great skua (*Stercorarius skua*)

4.21.1 Protection and Conservation Status

The great skua is listed in Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.21.2 Background

Great skua		
GB population	Breeding: 9,650 prs.	Mitchell *et al* 2004
Scottish population	Breeding: 9,650 prs.	Forrester *et al.* 2007
International threshold	Unknown	-
GB threshold	192 ind.	1% of GB Pop[n]
Designated east coast sites where species is a noted feature	None	SNH 2011b JNCC 2011a
European population estimate	Breeding 16,000 pairs Wintering – unknown	Birdlife 2004
European population trend	Status 'secure' Trend 'Large increase'	Birdlife 2004
World population	16,000 prs.	Mitchell *et al* 2004

Approximately 60% of the world population of great skua nest in the UK, all of which nest in north and north-west Scotland. They are summer migrants to the UK arriving at their breeding colonies in April, egg laying in May and June and departing primarily during August and September (Votier *et al*. 2004). During the breeding season non-breeding immature birds may also be present at the colonies. Following breeding, birds disperse into the North Sea and Atlantic and migrate southwards to their wintering grounds in the Bay of Biscay and West Africa. Autumn passage of great skuas is estimated to be between 2,000 to 10,000 birds when they remain largely offshore occurring in relatively low densities across the North Sea (Forrester *et al.* 2007).

During the breeding season they feed on fish, often following fishing vessels or by kleptoparasitising fish from other seabirds but they will also kill smaller seabirds. Tagging studies have indicated that during the breeding season great skuas either remain near to the seabird colonies predating other seabirds or they forage further offshore feeding on fish. Tagged great skuas in Shetland indicate that they forage to the west of Shetland (Votier *et al*. 2004; Thaxter *et al*. 2011).

In North-east Scotland great skuas occur between April and November with peak numbers in July and August with up 10 birds per hour past Peterhead (NESBR, Innes 1993).

Boat-based surveys

Great skuas were recorded from June to September with a total of 44 sightings over the two years of survey coverage. Sightings were recorded throughout the bay with no areas of significant concentrations recorded and few records from within the proposed EOWDC development area (Appendix B). Encounter rates based on combined Year 1 and Year 2 data indicate a peak in the number of great skuas present within Aberdeen Bay during August when up to 0.04 birds per km surveyed occur (Figure 4-44).

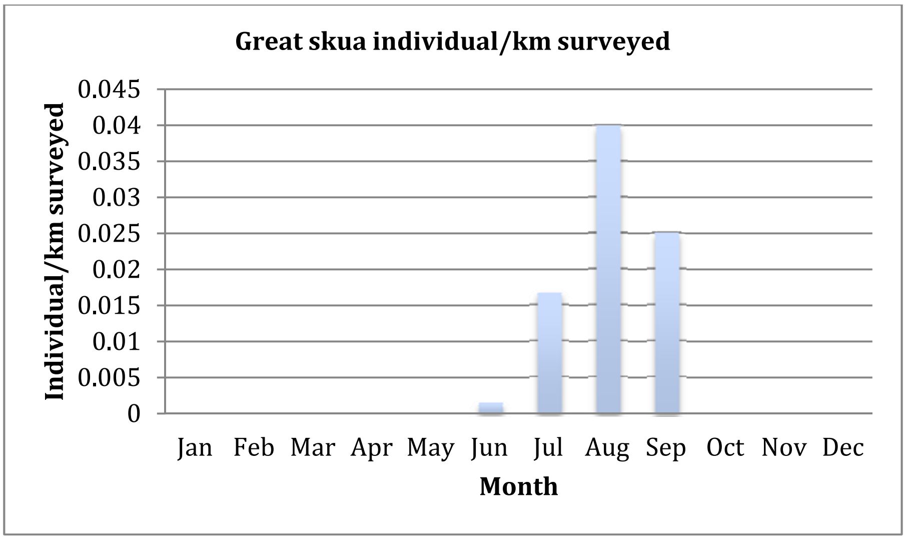


Figure 4-44: Encounter rates of great skua in Aberdeen Bay from boat-based surveys.

Vantage Point surveys

Great skuas were recorded in relatively low numbers from vantage point counts between April and October with peak counts during August and September when up to three birds per hour were recorded. Most observations of birds were between 1 and 3 km from shore and between 84% and 87% were flying below 30 m.

Bird Detection Radar

Ten great skuas were recorded during the radar studies in October 2005 and seven during April 2007. All but one of the sightings was of single birds (Walls *et al*. 2006, Simms *et al.* 2007).

4.21.3 Summary of Results

Great skuas were widely recorded across Aberdeen Bay in relatively low numbers from all surveys from between April and October. Peak counts were during the period of autumn migration when up to three birds per hour were recorded in August and September. There were also a smaller number of sightings during the spring migration with most records from April.

Of those recorded in flight, during boat-based surveys, 19% were recorded flying above 25 m and between 13% and 16% were recorded above 30 m from land-based surveys.

No counts of great skua from any of the surveys undertaken within Aberdeen Bay were of national importance.

4.21.4 Species Sensitivities

Qualifying species

There are no SPAs in the region for which the great skua is a qualifying species but over 73% of the UK breeding population of great skuas do occur in SPAs in northern Scotland.

Flight height

Observations from boat-based surveys undertaken in Aberdeen Bay recorded 19% of flight heights as being between 25 m and 200 m.

Elsewhere in the UK out of 1,182 recorded flight heights of great skua obtained from boat-based surveys, modelling results predict 6.5% as being at rotor height (Cook *et al*. 2012).

Collision risk

Data obtained from boat-based and land-based surveys recorded a total of 44 great skuas across Aberdeen Bay over the two years of boat-based surveys particularly during the autumn passage periods. There are relatively little data from other constructed offshore wind farms to determine possible avoidance rates but these are assumed to be relatively high at 95% or greater and at least 81% of flights are below rotor height.

Based on the relatively low usage of the site, the broad distribution of great skua across Aberdeen Bay and the high percentage of birds recorded as flying below rotor height it is concluded that there is a low risk of collision. Should it occur the number of great skuas recorded in Aberdeen Bay suggest that the frequency of collision will be very low and consequently the impacts on the species will be temporally long-term and of negligible magnitude and significance.

Barrier effect

There are no data from any constructed wind farms to determine whether or not a barrier effect may occur. Should it do so, there will be an incremental increase in energy expenditure as the bird flies around the wind turbines. However, the increase in flight distance caused by doing so will be insignificant for a bird flying to or from its wintering grounds in the Bay of Biscay or West Africa and its breeding grounds in northern Scotland; a distance of at least 2,000 km (Magnusdottir 2011). Consequently, the significance of any increase in energy expenditure by flying around the proposed development will, if it occurs, be temporally long-term and of negligible magnitude and significance.

Displacement

There are no data available to determine whether great skuas may be displaced from the proposed development area. Should they do so then they will forage elsewhere for their prey whether that is from scavenging behind fishing vessels, predating other birds or by Kleptoparasitism. There is no indication, based on the number and distribution of sightings, that the proposed development area is of any significant importance for great skua and the total footprint from the proposed development is relatively small compared to the potential foraging area available for great skua. Therefore, it is predicted that any displacement, should it occur, will be temporally long-term, of negligible magnitude and significance.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on great skuas.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth. Data from the Beatrice Demonstrator Project recorded 51 great skuas over a period of 12 months pre-construction surveys (Talisman 2005). The proposed Beatrice offshore wind farm recorded 91 great skuas over a two year period (BOWL 2012). No data are available from the proposed developments in the Firth of Forth or from the Moray Firth offshore wind farm. Collision risk modelling undertaken for the proposed Beatrice offshore wind farm indicates up to 25 great skuas may collide per year based on a 98% avoidance rate.

Table 4-45: Summary of significance of potential impacts on great skua.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Low	Negligible	Medium	Negligible
Operation	Collision	High	Negligible	Long-term	Negligible
	Displacement	Low	Negligible	Long-term	Negligible
	Barrier	Low	Negligible	Long-term	Negligible
Decommissioning	Displacement	Low	Negligible	Medium	Negligible
Cumulative	All	High	Negligible	Long-term	Negligible

4.21.5 Conclusions

Habitats Appraisal

There are no SPAs in the region for which great skua is a qualifying species.

Environmental Impact Assessment

Based on the relatively low densities of great skuas recorded in Aberdeen Bay and their broad distribution it is predicted that there will not be a significant effect arising from the proposed development on great skuas.

4.22 Arctic skua (*Stercorarius parasiticius*)

4.22.1 Protection and Conservation Status

The Arctic skua is listed in Appendix III of the Bern Convention and is on the Red List of Species of Conservation Concern.

4.22.2 Background

Arctic skua		
GB Population	Breeding: 2,100 prs.	Mitchell *et al* 2004
Scottish population	Breeding 2,100 prs.	Forrester *et al*. 2007
International threshold	Unknown	-
GB threshold	50	Minimum
Designated east coast sites where species is a noted feature	None	SNH 2011b JNCC 2011a
European population estimate	Breeding 40,000 – 140,000 pairs Wintering – unknown	Birdlife 2004
European population trend	Status 'secure' Trend 'unknown'	Birdlife 2004
World population	85,000 – 340,000 prs.	Mitchell *et al* 2004

Within the UK Arctic skuas only nest in north and western Scotland where they are a summer migrant arriving on their breeding grounds during April and May and departing primarily in August and September (Forrester *et al.* 2007). They feed on fish, primarily sandeels, which they often obtain from other seabirds by kleptoparasitsm as they enter the seabird colonies (BirdLife International 2012).

During migration from August to October, Arctic skua occur widely offshore in low densities across the North Sea but may favour inshore waters where they can scavenge food from other seabirds, particularly Terns (BirdLife International 2012; Stone *et al.* 1995). In North-east Scotland peak passage occurs during August with a maximum recorded passage of 326 Arctic skuas over a four hour period in August 1983 passing Peterhead (Buckland, Bell and Picozzi 1990).

Boat-based surveys

A total of 94 Arctic skuas were recorded from ship-based surveys undertaken over a period of two years. Arctic skuas were recorded widely throughout the bay with no concentrations identified (Appendix B).

Peak numbers were recorded during September with an encounter rate of 0.07 birds/km travelled (Figure 4-45).

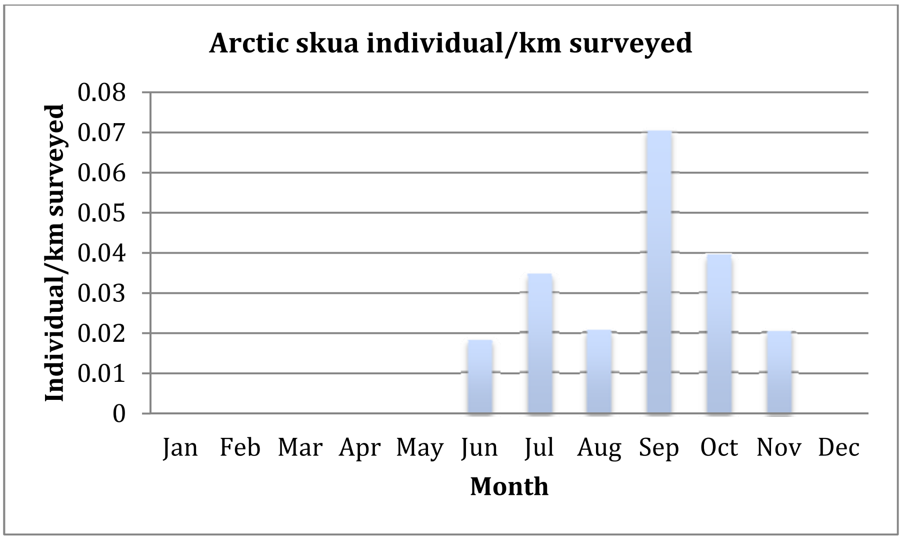


Figure 4-45: Encounter rates of Arctic skua across Aberdeen Bay from two years of boat-based surveys.

Vantage Point surveys

In Aberdeen Bay Arctic skuas were recorded between April and October with peak numbers of up to five birds per hour in July (EnviroCentre 2007). Birds were recorded out to 3 km from shore with at least 78% of the sightings below turbine height.

Bird Detection Radar

Fourteen Arctic skuas were recorded by visual observations undertaken during radar studies in October 2005 and a further single observation was made at Blackdog in April 2007 (Walls *et al.* 2006, Simms *et al.* 2007).

4.22.3 Summary of Results

Arctic skuas were widely recorded across Aberdeen Bay in relatively low numbers from all surveys from between April and October. Peak counts from boat-based surveys were during September although from land-based observations peak numbers were recorded during July when up to five birds per hour were counted from land-based observations.

Of those recorded in flight, 22% were recorded flying above 25 m from boat-based surveys and 22% above 30 m from land-based surveys.

No counts of Arctic skua from any of the surveys within Aberdeen Bay were of national importance.

4.22.4 Species Sensitivities

Qualifying species

There are no SPAs in the region for which the Arctic skua is a qualifying species but over 24% of the UK breeding population of Arctic skuas do occur in seven SPAs in Orkney and Shetland.

Flight height

Observations from boat-based surveys undertaken in Aberdeen Bay reported 16% of all flights above 25 m.

Elsewhere, out of 328 recorded flight heights for Arctic skua modelling predicts 3%, of flights at rotor height (Cook *et al*. 2012).

Collision risk

In order to determine potential effects of collision on Arctic skua a collision risk assessment has been undertaken (Appendix A1).

The CRM predicts between 0 and 1 Arctic skua may collide with the proposed development depending on the avoidance rate selected and use of site specific or generic modelled data (Table 4-21).

Table 4-46: Arctic skua predicted collision mortalities per year.

Rochdale	Flight height data source	Avoidance rate (%)			
		95.0	98.0	99.0	99.5
Original	EOWDC	1 +/- 1.32	0 +/- 0.53	0 +/- 0.26	0 +/- 0.13
	Generic	0 +/- 0.17	0 +/- 0.13	0 +/- 0.03	0 +/- 0.02
Revised	EOWDC	1 +/- 1.06	0 +/- 0.42	0 +/- 0.21	0 +/- 0.11
	Generic	0 +/- 0.14	0 +/- 0.10	0 +/- 0.02	0 +/- 0.02

Based on the precautionary avoidance rate of 98% it is predicted that there will be less than one collision per year.

Data obtained from boat-based and land-based surveys recorded Arctic skuas across Aberdeen Bay in relatively low numbers particularly during the autumn passage periods. There is very little data from other constructed offshore wind farms to determine possible avoidance rates but it is presumed to be relatively high, at least 95%, based on behaviour of most other species of seabird. In Aberdeen Bay 84% of flights were below rotor height.

Based on the relatively low usage of the site by Arctic skua, the broad distribution of Arctic skua across Aberdeen Bay and the number of birds recorded as flying below rotor height it is concluded that there is a low risk of collision. Should it occur it is, based on the number of Arctic skuas recorded in the proposed development area, predicted to be an infrequent event and therefore its impact on the species population is predicted to be temporally long-term and of negligible magnitude and significance.

Barrier effect

Data from post-construction monitoring studies undertaken in Denmark indicate that Arctic skua do not avoid entering wind farms. Consequently, there is not thought to be a barrier effect (Zucco *et al*. 2006). Any impacts, should it occur will be temporally long-term and of negligible magnitude and significance.

Displacement

There are no data available to determine whether Arctic skuas may be displaced from the proposed development area. However, they are known to follow Gulls and terns, which may enter the proposed development area and Arctic skuas have been shown not to avoid wind farms. Therefore, based on the known and predicted behaviour of Arctic skua there is no indication any potential displacement effect. Peak numbers of Arctic skua occur in Aberdeen Bay during the post-breeding season and are therefore likely to be birds on passage to and from their wintering grounds off south-west Africa and eastern South America (Snow and Perrins 1998); a distance in excess of 8,000 km. Therefore, should displacement occur from the proposed development area, its impact is predicted to be temporally long-term and of negligible magnitude and significance.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on Arctic skuas.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth. The only data available is that from the Beatrice Demonstrator Project which recorded 16 Arctic skuas over a period of 12 months pre-construction surveys and 19 over two years of surveys at the proposed Beatrice offshore wind farm (BOWL 2012; Talisman 2005). Collision risk modelling undertaken for the proposed Beatrice offshore wind farm indicate that up to 11 collisions per year may occur, based on a 98% avoidance rate. There are no data available for other planned developments in Round 3 or Scottish Territorial Waters. However, although Arctic skuas will be recorded within the area, the relatively far distance the proposed EOWDC is from the other planned offshore wind farms and its relatively small scale reduces the risk of a potentially significant cumulative or in-combination effect.

Table 4-47: summary of significance of potential impacts on Arctic skua.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Low	Negligible	Medium	Negligible
Operation	Collision	High	Negligible	Long-term	Negligible
	Displacement	Low	Negligible	Long-term	Negligible
	Barrier	Low	Negligible	Long-term	Negligible
Decommissioning	Displacement	Low	Negligible	Medium	Negligible
Cumulative	All	High	Negligible	Long-term	Negligible

4.22.5 Conclusions

Habitats Appraisal

There are no SPAs in the region for which Arctic skua is a qualifying species.

Environmental Impact Assessment

Based on the relatively low numbers of Arctic skuas recorded in Aberdeen Bay and their broad distribution, it is predicted that there will not be a significant effect arising from the proposed development on Arctic skuas.

4.23 Golden plover (*Pluvialis apricaria*)

4.23.1 Protection and Conservation Status

Golden plover is listed in Annex I of the Birds Directive, Schedule II of the Wildlife and Countryside Act, Appendix II of the Bonn Convention. Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.23.2 Background

Golden plover		
GB Population	Summer: 23,000 prs. Winter: 250,000 ind.	BTO 2011
Scottish Population	Summer – 15,000 prs. Autumn – 20,000 – 60,000 ind. Winter: 25,000 – 35,000 ind.	Forrester *et al.* 2007
International threshold	9,300 ind.	Calbrade *et al.* 2010
GB threshold	4,000 ind.	Calbrade *et al.* 2010
Designated east coast sites where species is a noted feature	Firth of Forth: 2,970 ind.	SNH 2011b JNCC 2011
European population estimate	Breeding 436,000- 740,000 prs Wintering – 820,000 ind.	Birdlife 2004
European population trend	Status 'secure' Trend 'unknown breeding moderate increase wintering	Birdlife 2004
World population	640,000 to 1,200,000 ind.	Birdlife 2011

Golden plover breed on upland moorlands in northern Britain and Europe with the largest European populations in Iceland where up to 310,000 pairs (BirdLife 2004).

The UK holds 80% of the breeding population of the southern race of golden plover *P. apricaria apricaria,* which has undergone a significant decline of 20% between the 1960's and 1980's (EC 2009). The breeding population occurs widely across the uplands of northern Britain and particularly Scotland where an estimated 15,000 pairs occur (Forrester *et al*. 2007). In North-East Scotland an estimated 1,600 pairs nest on hills inland up Deeside and Donside (Rae 2011).

In winter the UK population increases with birds arriving from Iceland and the Continent where they spend the winter on arable land, often winter crops, and open grassland. Birds return to the same areas and often same fields each year. Golden plover recorded in eastern Britain are thought to be predominantly birds from Scandinavia or further east whereas those from Iceland occur predominantly in western Britain and Ireland. Birds occurring in North-east Scotland are therefore most likely to be local breeding birds and from populations to the north and east (Wernham *et al*. 2002).

In North-east Scotland golden plover occur widely during the winter at a few favoured locations near the coast each winter. Peak numbers in the region occur on the Ythan Estuary during the autumn. Maximum counts in recent years have been up to 9,000 birds but more often peak numbers are between 3,000 to 4,000 individuals (Buckland Bell and Picozzi 1990; NESBR). Birds forage and roost on the Ythan at low tide but move away as far as 10 km during high tides (Buckland Bell and Picozzi 1990).

Boat-based surveys

Two golden plover were recorded flying west between 2 and 10 metres above sea level from boat-based surveys in September 2007.

Vantage Point surveys

No golden plover were recorded from vantage point surveys.

Bird Detection Radar

Golden plover were observed on three occasions at Drums, in large numbers during radar and visual surveys undertaken in October 2005. A total of 2,170 golden plover were recorded in three flocks along the shoreline and out to 3,300 m. Their mean flight height was 35 m and therefore at potential risk of collision (Walls *et al.* 2006).

4.23.3 Summary of Results

Only two golden plover were recorded from boat-based surveys with the majority of records obtained during land-based surveys undertaken in October 2005. The majority of sightings were of birds along the shore, although one flock occurred out as far as 3,300 metres offshore.

4.23.4 Species Sensitivities

Qualifying species

Golden plover is a qualifying species as part of an assemblage for the Firth of Forth SPA.

Flight height

Flight heights recorded from land-based surveys undertaken in October 2005 recorded a mean flight height of 35 m. Elsewhere, very few golden plover have been recorded at offshore wind farms and all have been below turbine height.

Collision risk

Results from site specific monitoring and other data sources (e.g. NESBR) indicate that golden plover are rarely recorded offshore in Aberdeen Bay. However, flocks of golden plover can occur. The only flock recorded offshore was to the north of the proposed development and were of birds likely associated with the Ythan Estuary also to the north. Bird detection radar recorded golden plover flocks moving between Drums and the Ythan Estuary (Walls *et al.* 2006; Simms *et al*. 2007). Therefore, golden plover recorded at Drums are not at risk of collision with the proposed development. It is possible that golden plover may cross Aberdeen Bay during periods of passage. However, there is no indication from land-based or boat-based surveys that there are any regular movements across the bay nor that there is a flyway across the proposed development area (e.g. NESBR).

Studies undertaken in Denmark have indicated that golden plover fly above the turbine height during passage and are not at risk of collision and that other species of wader flying at rotor height demonstrated effective avoidance behaviour when near to offshore wind turbines (Petersen *et al.* 2006). Consequently, there are data available to indicate that the risk of collision to golden plover in Aberdeen Bay is very low and that the potential effect from collision, should it occur, will be temporally long-term and of negligible magnitude and significance.

Barrier effect

Data obtained from nearly two years of vantage point surveys plus additional radar studies and two years of boat-based surveys did not record regular daily flights by golden plover across the proposed development area. Therefore, a regular barrier effect that may cause a long-term increase in daily energetic costs is not predicted. There is the potential for a relatively small *ad hoc* increase if golden plover cross the bay during migration but this would cause a very small incremental increase in energetic costs compared to their overall energetic expenditure during migration. It is predicted that the potential impacts arising from barrier effect will be temporally long-term and of negligible magnitude and significance due to the relatively small incremental increase in flight distance compared to the likely total length of migration.

Displacement

No golden plover were recorded at the proposed development area and therefore no displacement effects will occur.

Cumulative and in-combination

It is possible that birds migrating long distances from Scandinavia or Russia may interact with one or more wind farm. However, it is not known where the golden plover recorded at the Ythan Estuary originate from or where they may migrate to and therefore it is not possible to undertake an evidence based cumulative or in-combination impact assessment.

The only data available that may be of relevance are from the Beatrice demonstrator project, which did not record any golden plover during its surveys and the Beatrice offshore wind farm where eight golden plover were recorded over two years of surveys (BOWL 2012). Data from other proposed projects in the Moray Firth and the Firth of Forth are not currently available.

Table 4-48: Summary of significance of potential impacts on golden plover.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Low	Negligible	Medium	Negligible
Operation	Collision	Medium	Negligible	Long-term	Negligible
	Displacement	Low	Negligible	Long-term	Negligible
	Barrier	Medium	Negligible	Long-term	Negligible
Decommissioning	Displacement	Low	Negligible	Medium	Negligible
Cumulative	All	Medium	Negligible	Long-term	Negligible

4.23.5 Conclusions

Habitats Appraisal

Based on the very low usage of the proposed development area by golden plover and some evidence from existing offshore wind farms indicating a low collision risk, there will not be any adverse effects on the Firth of Forth SPA for which golden plover is a qualifying species.

Based on site specific data and evidence from existing offshore wind farms it is predicted that there will not be a significant environmental effect arising from the proposed development on golden plover.

4.24 Black-legged kittiwake (*Rissa tridactyla*)

4.24.1 Protection and Conservation Status

The (black-legged) kittiwake is listed in Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.24.2 Background

Kittiwake		
GB population	Breeding: 370,000 prs.	Mitchell *et al* 2004
Scottish population	Breeding: 282,200 AoN Winter: est. 10,000 ind.	Forrester *et al*. 2007
GB threshold	unknown	Calbrade *et al*. 2010
International threshold	20,000 ind.	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	Buchan Ness to Collieston Coast: 14,133 AoN (2007) Fowlsheugh: 11,140 AoN (2006) Forth Islands: 2,316 AoN (2009) Troup Pennan and Lion's Head: 14,896 AoN (2007) East Caithness Cliffs: 3,561 prs. (2005)	SNH 2011b JNCC 2011a
European population estimate	Breeding 2,100,000 to 3,000,000 prs. Wintering – >200,000 ind.	Birdlife 2004
European population trend	Status secure' Trend 'moderate decline	Birdlife 2004
World population	17 – 18,000,000 ind.	Birdlife 2011

Kittiwakes are the most numerous species of gull in the world and are highly pelagic (BirdLife International 2012). It is the most abundant breeding gull in the UK with an estimated 370,000 pairs in the UK, of which 282,000 occur in Scotland (Mitchell *et al*. 2004; Forrester *et al.* 2007). The species nests often in large colonies on coastal cliffs. Kittiwakes start arriving back at their colonies during March and April and depart during August and September (Schofield 2011b). During the breeding season they can forage widely with adults flying in excess of 100 km to suitable foraging sites although the mean foraging range is 27 km (BirdLife International 2012, Thaxter *et al*. 2012).

Post-breeding, both adults and juveniles disperse across the North Sea and the North Atlantic with a greater proportion of unsuccessful breeders wintering off eastern Canada compared to those that have been successful, that winter largely in the eastern Atlantic (Bogdanova *et al*. 2011).

In North-east Scotland kittiwakes are recorded throughout the year but with lowest numbers between November and March and peak numbers generally during July and August (NESBR). On occasions there are records of exceptionally large movements of kittiwakes along Aberdeenshire coast. In April 1978 over 44,000 kittiwakes were recorded flying past Collieston and over 80,000 are estimated to have flown past Aberdeenshire on 29 October 1969 (Buckland, Bell and Picozzi 1990).

Observations off Peterhead occur out to at least 3 km with most records of birds closest to shore during poor weather (Innes 1991).

Boat-based surveys

Kittiwakes were the most frequently recorded gull from boat-based surveys. They were recorded throughout Aberdeen Bay with the majority of sightings in water depths of between 10 m and 20 m and between 1 km and 3 km from the shore.

Relatively low numbers of kittiwake were recorded during the winter period and few within the footprint of the proposed development area (Appendix B). Peak numbers occurred during the breeding season between April and July, with highest numbers, in Year 1, to the north. Post-breeding, the numbers of kittiwake recorded decreased with lower numbers recorded within the proposed development area. Further data collected from between August 2010 and August 2011 indicated greater numbers within the vicinity of the proposed development compared to elsewhere (Appendix B).

Year 1 data showed a strong seasonal variation in the number of kittiwakes recorded, with relatively high numbers in June and July when there was a peak of 2,339 kittiwakes within the total surveyed area of which 72% were within the 'control' area. Outwith the peak period numbers of kittiwakes recorded were relatively low with an estimated abundance of less than 14 birds in the proposed EOWDC development area during the autumn and only one bird during the winter period. Peak density estimates occurred during the spring and summer when up to 33 birds/km^2 were recorded (Figure 4-46**).**

Monthly data collected from between August 2010 and August 2011 recorded peak abundance estimate of 947 kittiwakes in the south of the survey area in July and 559 birds in the northerly survey area during June (Figure 4-48.).

Table 4-49: Seasonal estimates of density and abundance of kittiwakes in the proposed EOWDC and 'control' areas (Year 1).

Season	Density Estimate (km^2)	SE	Estimated Abundance	SE	No. Observations
EOWDC- Winter	0.025	0.025	1	1.3	1
Control- Winter	0.049	0.050	3	2.5	2
EOWDC- Spring	0.453	0.229	23	11.6	12
Control- Spring	21.383	15.748	1,086	800.0	16
EOWDC- Summer	13.046	6.251	663	317.6	33
Control- Summer	33.000	11.277	1,676	572.9	60
EOWDC- Autumn	0.276	0.206	14	10.5	7
Control- Autumn	0.332	0.149	17	7.5	9

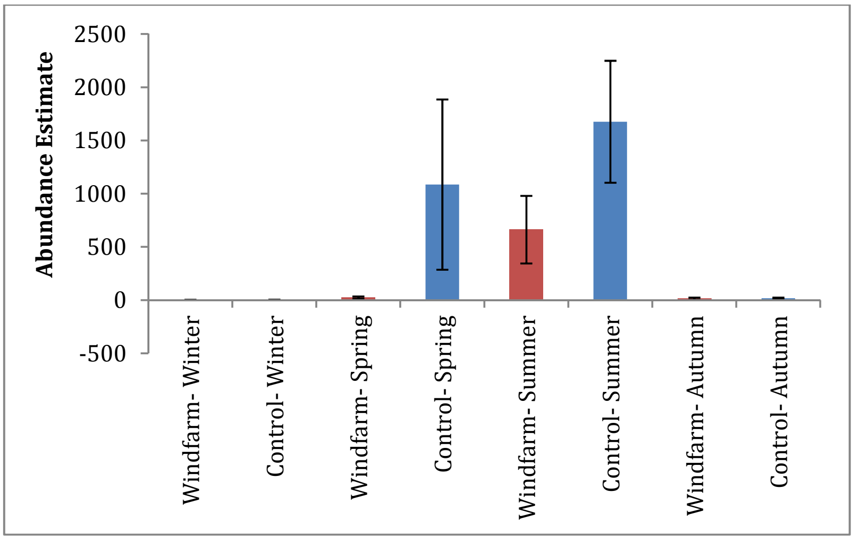


Figure 4-46: Seasonal estimates (+/- SE) of abundance of kittiwakes in the proposed EOWDC and 'control' areas; February 2007 – January 2008.

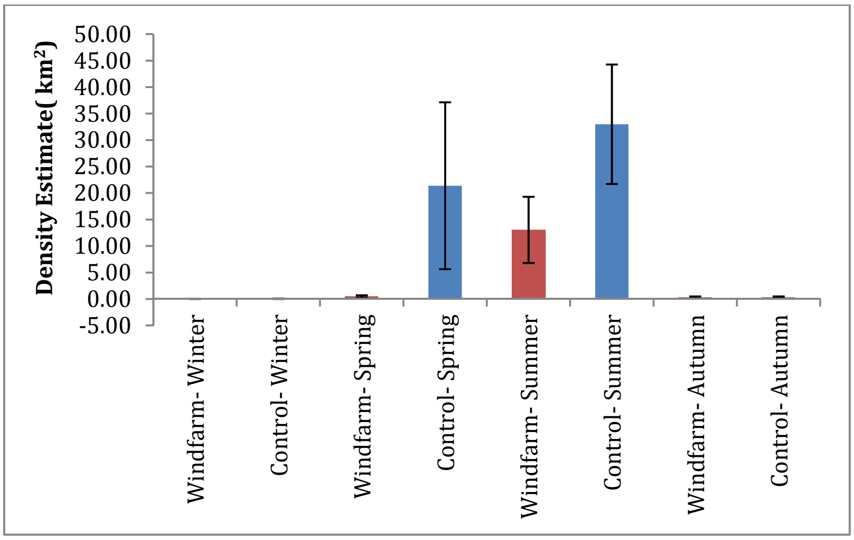


Figure 4-47: Seasonal estimates (+/- SE) of density of kittiwakes in the proposed EOWDC and 'control' areas.

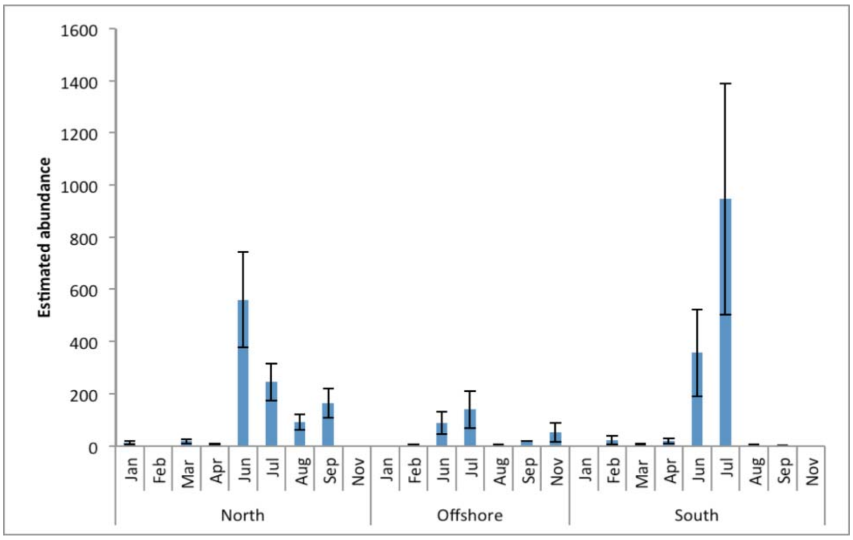


Figure 4-48: Monthly estimates (+/- SE) of abundance of Black-legged Kittiwake in the South, North and Offshore Strata; August 2010 to January 2011.

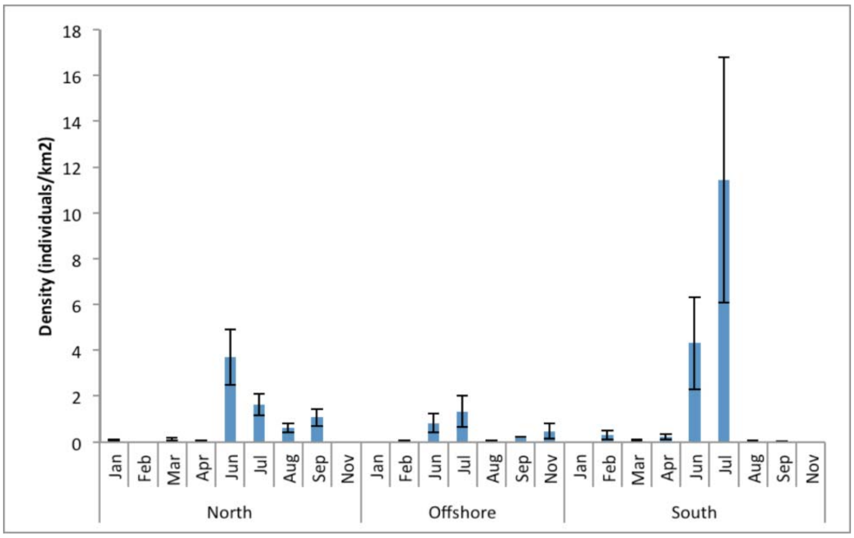


Figure 4-49: Monthly estimates (+/- SE) of density of Black-legged Kittiwake in the South, North and Offshore Strata; August 2010 to January 2011.

Vantage Point Surveys

Vantage point counts at four locations within Aberdeen Bay recorded kittiwakes throughout the year. Peak numbers were of up to 200 birds per hour in July 2006 but numbers of passing birds were more frequently at <100 birds per hour (Alba Ecology 2008a). During the winter months there were considerably fewer kittiwakes present in Aberdeen Bay with less than 10 birds per hour recorded (Alba Ecology 2008b). Birds were recorded out to 3 km from shore with peak numbers within 1-3 km and at least 42% of sightings were of birds flying between 30-150 m from the sea surface.

Bird Detection Radar

One kittiwake was recorded at Easter Hatton during the radar studies undertaken in October 2005 (Walls *et al*. 2006) and 26 were recorded during April 2007 radar surveys at a rate of 0.5 birds per hour (Simms *et al.* 2007).

4.24.3 Summary of Results

Kittiwakes were recorded throughout Aberdeen Bay in highly seasonally variable numbers. During the winter periods very few kittiwakes were recorded. However during the breeding season kittiwakes were frequently recorded with estimated populations within the 'control' area during this period of 1,676 birds and 663 birds in the proposed EOWDC development area. Peak densities of 33 birds/km^2 were recorded to the north of the proposed development during the summer months. Land-based observations also recorded peak numbers during the summer months with a peak in July. Of those for which flight height was recorded from boat-based surveys, 18.5% were greater than 25 m above the sea surface.

4.24.4 Species Sensitivities

Qualifying species

Kittiwake is a qualifying species for five SPAs within the region: Buchan Ness to Collieston, Fowlsheugh, Troup, Pennan and Lion's Head and Forth Islands SPAs and East Caithness Cliffs.

Flight height

Flight altitude data obtained from boat-based surveys reported 18.5% of flights at above 25 m.

Elsewhere, out of over 62,676 recorded flight altitudes modelling predicts 16% of flights at rotor height (Cook *et al.* 2012).

Collision risk

Site-specific survey results and other data sources indicate that kittiwakes are widespread and frequent within Aberdeen Bay and with a distinct seasonal peak during the summer months.

In order to determine potential effects of collision on kittiwake a collision risk assessment has been undertaken (Appendix A1).

The CRM predicts between 7 and 86 kittiwakes may collide with the proposed development depending on the avoidance rate selected and use of site specific or generic modelled data (Table 4-50).

Table 4-50: Kittiwake predicted collision mortalities per year.

Rochdale	Flight height data source	Avoidance rate (%)			
		95.0	98.0	99.0	99.5
Original	EOWDC	112 +/- 90.95	45 +/- 36.39	22 +/- 18.20	11 +/- 9.10
	Generic	97 +/- 78.63	39 +/- 31.47	19 +/- 15.74	10 +/- 7.87
Revised	EOWDC	86 +/- 69.64	34 +/- 27.86	17 +/- 13.93	9 +/- 6.97
	Generic	74 +/- 60.22	30 +/- 24.99	15 +/- 12.05	7 +/- 6.02

Based on the precautionary avoidance rate of 98%, it is predicted that up to 34 collisions per year may occur.

During the breeding season (April to August) an estimated 27 kittiwakes are, predicted to collide (Table 9-39). Of those that were aged, 94% were aged as adults during the breeding season and therefore 25 kittiwakes at risk of collision during the breeding season will be potentially breeding adults.

There are two SPAs within the mean maximum foraging range of kittiwake: Buchan Ness to Collieston Coast SPA and Fowlsheugh SPA.

To determine the potential impact on each of the two SPAs identified as having high potential for connectivity the potential collision mortality is apportioned between the two sites based on the distance from the colony and the number of individuals within each colony.

Table 4-51: Predicted number of collisions during breeding period at each SPA with high degree of connectivity.

SPA colony	Kittiwake		
	Distance to colony (km)	Number of collisions predicted	% of SPA population
Buchan Ness to Collieston Coast	9.5	19	0.06
Fowlsheugh	32	6	0.02

The annual mortality rate for kittiwake is 6% (BTO 2011). Based on the regional SPA population of kittiwakes of 92,092 individuals, the annual mortality rate will be approximately 5,525 individuals and therefore the 1% baseline mortality rate is 55 birds per year. The results from the collision risk modelling predict a total of 25 adult kittiwakes per breeding season may collide with the wind turbines and therefore equivalent to an increase in the baseline mortality rate of 0.45%.

The Buchan Ness to Collieston Coast SPA lies approximately 9.5 km away from the proposed development and holds approximately 28,266 breeding kittiwakes, based on the latest available counts in 2007. Due to recent declines in the breeding population it is currently considered to be in an unfavourable conservation status. The annual adult mortality of the colony is estimated to be 1,696 birds. The results from the collision risk modelling predict up to 19 adult kittiwakes per breeding season may collide with the proposed development, which is 0.06% of the SPA breeding population (Table 4-51) and an increase in baseline mortality of 1.1%.

In 1995 the population of kittiwakes at Buchan Ness to Collieston Coast SPA was 24,957 pairs and decreased to 14,133 pairs by 2007. This is a decrease of 902 pairs, 1,804 individuals per year. The additional potential increase in mortality of up to 19 birds per year is relatively small compared to the current rate of decline and is not predicted to significantly affect the current population levels.

The Fowlsheugh SPA lies 32 km away from the proposed development and holds 11,140 breeding pairs of kittiwake based on latest counts. Therefore, the annual adult mortality rate from this colony is estimated to be 1,337 birds per year. It is currently considered to be in a favourable conservation status. Based on the results from the collision risk modelling it is concluded that six collisions per breeding season may occur from the proposed development area, which is 0.02% of the SPA breeding population and an increase in baseline mortality of 0.4%.

Other SPAs are further away from the proposed development and the number of potential collisions is predicted to be less than one bird per year.

Based on the results of the collision risk modelling and the current regional and SPA populations, it is predicted that that the potential population affect caused by collision impacts with the proposed development on kittiwakes is negligible. However, it also recognised that the breeding population of kittiwakes at Buchan Ness to Collieston SPA is in an unfavourable but maintained condition and any increase in adult mortality will not improve the condition of the site. The predicted number of collisions of 19 adult kittiwakes during the breeding season is relatively small, less than 0.1% of the breeding population.

It is predicted that impacts from collision may be long-term but will be of negligible magnitude and the potential increase in mortality will not have a significant incremental effect on the population over and above those factors causing the more significant decline in breeding numbers and of minor significance.

Barrier effect

Data from post-construction monitoring studies undertaken in Denmark and Netherlands indicate that although kittiwakes may make some avoidance response they are generally not affected by offshore wind turbines and do not avoid entering wind farms. Consequently, there is not thought to be a significant barrier effect on kittiwakes from the proposed development (Zucco *et al*. 2006; Leopold *et al.* 2011).

Displacement

Evidence from Denmark and the Netherlands indicate that there is no significant displacement effect from operating wind farms on kittiwakes (Zucco *et al*. 2006; Leopold *et al.* 2011). Therefore no displacement is predicted.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on kittiwakes.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth all of which have the potential to contribute to a possible in-combination effect. Surveys undertaken for the Beatrice Demonstrator Project recorded 2,943 kittiwakes over a period of 12 months of pre-construction surveys (Talisman 2005). Data for the proposed Beatrice offshore wind farm recorded 2,519 kittiwakes over a two year period (BOWL 2012). Collision risk modelling undertaken for the Beatrice Demonstrator Project predicted up to 9 kittiwakes per year might collide with the two turbines. Up to 263 kittiwakes per year (based on 98% avoidance rate) or 130 per year (based on 99% avoidance rate) are predicted to collide with the Beatrice offshore wind farm (BOWL 2012). Data presented in the Beatrice offshore wind farm environmental statement reports potential 186 kittiwake collisions per year for the Moray Firth offshore wind farm based on a 99% avoidance rate (BOWL 2012).

Data from the other Round 3 wind farms and those in Scottish Territorial Waters are not available.

The only SPA for which kittiwake is a qualifying species that could potentially have an in-combination impact between the proposed EOWDC and the proposed Moray Firth developments is Troup Pennan and Lion's Heads SPA. Not all kittiwakes predicted to collide with the proposed developments would originate from this SPA. Kittiwakes in the Moray Firth will be from other SPAs to the north, e.g. East Caithness Cliffs and North Caithness Cliffs. The two proposed Moray Firth developments are predicted to impact 0.01% of the Troup Pennan and Lion's Heads SPA (BOWL 2012). The potential small additional increase in mortality from the proposed EOWDC is predicted to have a minor significance. Consequently, it is not predicted that there will be an adverse in-combination effect between the proposed EOWDC and other offshore wind farms.

Table 4-52: Summary of significance of potential impacts on kittiwake.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Medium	Negligible	Medium	Negligible
Operation	Collision	Very High	Negligible	Long-term	Minor
	Displacement	Medium	Negligible	Long-term	Negligible
	Barrier	Medium	Negligible	Long-term	Negligible
Decommissioning	Displacement	Medium	Negligible	Medium	Negligible
Cumulative	All	Very High	Negligible	Long-term	Minor

4.24.5 Conclusions

Habitats Appraisal

There are two SPAs for which kittiwakes are a qualifying species in the region. Based on the results from the collision risk modelling and the predicted number of adult breeding kittiwakes at risk of collision per year from each of the SPAs and the likely foraging ranges of kittiwakes there will not be an adverse effect on the SPAs.

Environmental Impact Assessment

Based on the results from collision risk modelling undertaken and the potential number of kittiwakes, which may collide with the proposed development. It is predicted that there will not be a significant effect arising from the proposed development on the local or regional population of kittiwakes.

4.25 Black-headed gull (*Larus ridibundus*)

4.25.1 Protection and Conservation Status

The black-headed gull is listed in Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.25.2 Background

Black-headed gull		
GB population	Breeding: 130,000 prs. Wintering: 2.1 – 2,200,000 ind.	Mitchell *et al* 2004 BTO 2011
Scottish population	Breeding: 43,200 AoN Wintering: 155,500 ind.	Forrester *et al*. 2007
International threshold	20,000 ind.	Calbrade *et al*. 2010
GB threshold	19,000 ind.	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	None	SNH 2011b JNCC 2011a
European population estimate	Breeding 1.5 – 2,200,000 prs. Wintering – >3,200,000 ind.	Birdlife 2004
European population trend	Status 'secure' Trend 'moderate decline'	Birdlife 2004
World population	2.1 – 2,800,000 prs.	Mitchell *et al* 2004

Black-headed gulls are the most widespread breeding seabird in Britain and Ireland with similar numbers nesting inland as on the coast. The majority of the breeding population is semi-resident with the majority of the UK population undertaking only localised seasonal movements. However, the UK wintering population is bolstered by birds from northern and eastern Europe (Wernham *et al.* 2002).

Outside the breeding season black-headed gulls occur in inshore tidal waters largely avoiding rocky or exposed coasts, preferring inlets, bays and estuaries with sandy or muddy beaches (Snow and Perrins 1998). Black-headed gulls are primarily a coastal species and are scarce offshore (Stone *et al.* 1995).

In North-east Scotland black-headed gulls breed across the region, primarily in lowland marshes, coastal areas and along river valleys. Between 1,000 and 2,500 pairs nest in North East Scotland with the largest colonies at the Sands of Forvie (1,500 pairs) and Loch of Strathbeg (900 pairs). However, colonies can appear and disappear over years (Bourne 2011a).

Peak numbers at Peterhead occur between July and February with nearly all sightings of birds passing Peterhead within 200 m of the coast (Innes 1994). The number of wintering black-headed gulls is 13,500 individuals of which nearly 12,000 are found along the coast (Forrester *et al*. 2007)

Boat-based surveys

Nine sightings of black-headed gulls were made from boat-based surveys undertaken between February 2007 and April 2008. With eight of the nine sightings made in November and all were inshore (IECS 2008). A further ten sightings were made between August 2010 and August 2011, with six of them occurring during June.

Vantage Point surveys

Black-headed gulls occur throughout the year in Aberdeen Bay but there were large variations in numbers between years. In 2006, peak numbers occurred in June, with up to 5 birds per hour passing all within 2 km of the coast and the majority within 1 km (Figure 4-50) (EnviroCentre 2007). However, in 2007 peak counts occurred in July and August when up to 90 birds per hour passed the Donmouth (Alba Ecology 2008a). During the winter months numbers of black-headed gulls recorded were much lower with a peak count of less than 30 birds per hour in February 2008 (Alba Ecology 2008b). In 2006, 48% of sightings were within the 30-150 m height band across all vantage point sites and in 2007, 9% were within the same height band (Alba Ecology 2008a).

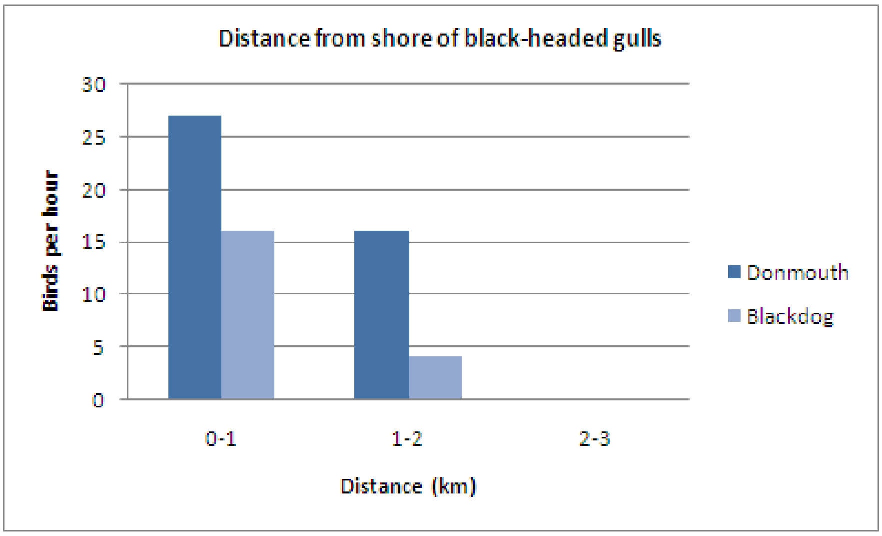


Figure 4-50: Number of black-headed gulls per hour recorded off Aberdeen Bay from Vantage Point Counts April 2006 – March 2008 and their distance from shore.

Bird detection Radar

One-hundred and forty-three black-headed gulls were recorded from observations undertaken during Bird Detection Radar surveys in October 2005 (Walls *et al.* 2006). Fourteen were recorded at Blackdog over a seventeen day period in April 2007 (Simms *et al.* 2007).

4.25.3 Summary of Results

Black-headed gulls were infrequently recorded from boat-based surveys with most observations of black-headed gulls made from vantage point surveys. Numbers of black-headed gulls varied between years and across the seasons. Lowest numbers were during the winter months and peak counts from shore-based counts were between June and August. Peak counts were of up to 90 birds per hour passing the Donmouth during July and August.

The majority of sightings were within 1 km of the coast with very few records beyond 2 km from the shore. Of those recorded in flight up to 48% were recorded flying between 30 m and 150 m but numbers at these heights varied considerably.

No counts of black-headed gulls from any of the surveys were of national importance.

4.25.4 Species Sensitivities

Qualifying species

There are no SPAs in the region for which black-headed gull is a qualifying species.

Flight height

Only six observations of flight altitudes were obtained from boat-based surveys. All were of birds flying below 25 m.

Elsewhere, out of 4,490 recorded flight altitudes for black-headed gull modelling predicts 13% of flights at rotor height (Cook *et al*. 2012).

Collision risk

Data obtained from boat-based and land-based surveys recorded black-headed gulls mainly within 1 km of the coast with most records during the summer months and lower numbers during the winter. Data from coastal wind farms have recorded relatively low avoidance behaviour towards wind turbines by black-headed gulls and they are known to collide with turbines (Zucco et al. 2006). However, nearly all the sightings of black-headed gull were within 2 km of the coast and the majority were within 1 km (Figure 4-50).

Boat-based surveys recorded very few black-headed gulls offshore at the proposed development site.

Although black-headed gull may be at higher risk of collision due to its regular flight height and the lack of significant avoidance behaviour recorded for the species; the location of the proposed development and number of black-headed gulls observed in the proposed development area suggest that any impact on black-headed gulls from the proposed development will be temporally long-term and of negligible magnitude and significance.

Barrier effect

Data from post-construction monitoring studies undertaken in Denmark indicate that black-headed gulls are generally not affected by offshore wind turbines and do not avoid entering wind farms. Consequently, there is not thought to be a significant barrier effect (Zucco *et al*. 2006). Any impacts will be of negligible magnitude and significance.

Displacement

Very few black-headed gulls were recorded within the area of the proposed development and black-headed gulls are not known to show any significant displacement effects. There is no indication of any potential displacement effect from post construction surveys (Zucco *et al.* 2006) but should it occur, its significance is predicted to be temporally long-term and of negligible magnitude and significance as black-headed gulls do not regularly use the proposed development area and remain largely in waters within 2 km of the coast.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on black-headed gulls.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth. The only data available are from the Beatrice Demonstrator Project which recorded six black-headed gulls over a period of 12 months pre-construction surveys (Talisman 2005) and the proposed Beatrice offshore wind farm, which recorded four black-headed gulls during two years of surveys (BOWL 2012). No other data for other future planned offshore wind farms are available. Consequently, it is not possible to determine whether there will be a cumulative or in-combination impact arising from the proposed plans. However, based on the predicted behaviour of black-headed gulls, in particular their predominantly coastal distribution (Stone *et al.* 1995), it is predicted that the risk of any cumulative or in-combination effects is low and the magnitude and significance negligible.

Table 4-53: Summary of significance of potential impacts on black-headed gull.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Low	Negligible	Medium	Negligible
Operation	Collision	High	Negligible	Long-term	Negligible
	Displacement	Low	Negligible	Long-term	Negligible
	Barrier	Low	Negligible	Long-term	Negligible
Decommissioning	Displacement	Low	Negligible	Medium	Negligible
Cumulative	All	Low	Negligible	Long-term	Negligible

4.25.5 Conclusions

Habitats Appraisal

There are no SPAs in the region for which black-headed gull is a qualifying species.

Environmental Impact Assessment

Based on the relatively low numbers of black-headed gulls recorded in Aberdeen Bay and that they were not recorded regularly in the proposed development area it is predicted that there will not be a significant effect arising from the proposed development on black-headed gulls.

4.26 Common gull (*Larus canus*)

4.26.1 Protection and Conservation Status

The common gull is listed in Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.26.2 Background

Common gull		
GB Population	Breeding: 48,000 prs. Winter: 620 – 721,000 ind.	BTO 2011
Scottish population	Breeding: 48,100 AoN Winter: 79,700 ind.	Forrester *et al*. 2007
International threshold	20,000 ind.	Calbrade *et al*. 2010
GB threshold	9,000 ind.	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	None	SNH 2011b JNCC 2011a
European population estimate	Breeding 590,000 – 1,500,000 pairs Wintering – >910,000	Birdlife 2004
European population trend	Status 'depleted' Trend 'unknown'	Birdlife 2004
World population	2,500,000 – 3,700,000 pairs	Birdlife 2011

Common gulls occur throughout much of Scotland breeding in colonies usually inland and foraging in fields, estuaries and nearshore waters. During the autumn the UK population is augmented by migrants from northern Europe, which winter in the UK (Wernham *et al*. 2002). In Scotland an estimated 100,000 to 200,000 common gulls occur during the spring and autumn passage (Forrester *et al.* 2007).

During the breeding season common gulls remain close to shore with relatively few sightings of common gulls from offshore waters. Outwith the breeding season common gulls disperse southward to southern Scotland and England but wintering birds remain largely in nearshore waters often occurring in large numbers in river estuaries where large roosts can occur. Spring passage occurs during March and April across a broad front (Stone *et al.* 1995).

Relatively few common gulls nest along the coast of North-east Scotland, although an increasing population have nested on the flat roofs of nearby industrial estates since 1984 (NESBR). Historically there were large breeding colonies inland up Deeside where peak counts were of up to 24,500 pairs in the Coreen Hills and 21,700 pairs at Mortlach. However, these colonies have reduced significantly from a combined total of the three largest colonies of 40,700 pairs in 1988/89 to 6,300 pairs in 2007/08. The estimated North-east Scotland population is between 7,000 and 9,000 pairs (Bourne 2011b).

In North-east Scotland peak numbers occur on the Ythan Estuary during October and November and there is some evidence of a spring and autumn passage of birds past Peterhead with up to 900 birds per month passing Peterhead during July and August (Buckland, Bell and Picozzi 1990).

Boat-based surveys

Common gulls were recorded throughout the year in Aberdeen Bay. Numbers were highest during the autumn, particularly November and February and March. Very few common gulls were recorded during June and July (Figure 4-51).

Although common gulls were widely recorded throughout the surveyed area the majority of records during the winter were off Aberdeen and Balmedie between 1 km and 3 km from shore. During the breeding season significantly fewer common gulls were recorded and most records were in nearshore waters with few birds recorded within the footprint of the proposed development. Post-breeding, the numbers of common gulls within Aberdeen Bay increased with widely scattered records in predominantly nearshore waters (Appendix B).

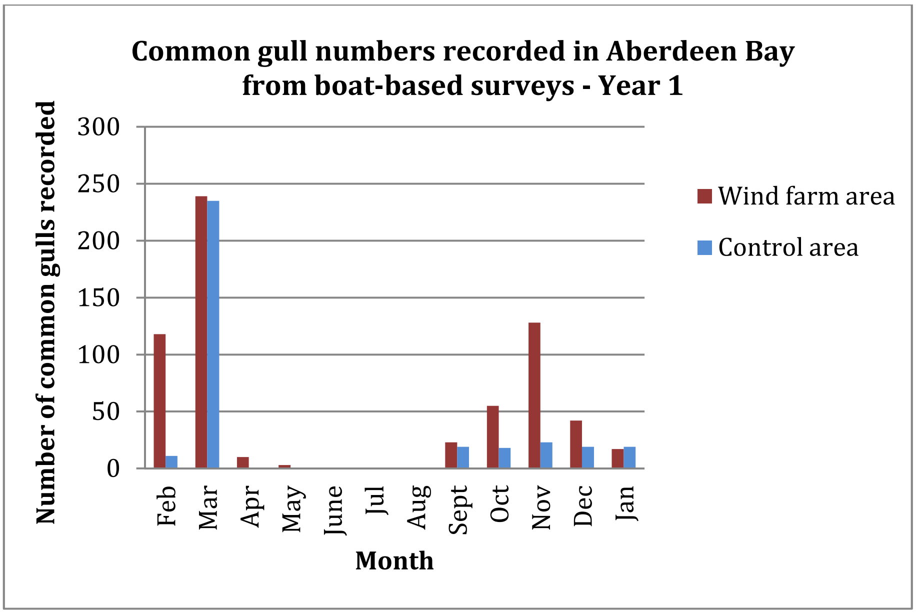


Figure 4-51: Common gull monthly population estimates in proposed EOWDC and 'control' areas: Boat-based surveys 2007 – 2008.

Based on Year 1 data there were not enough sightings to undertake a monthly assessment using *Distance*. However, estimated densities on seasonal basis were able to be calculated and estimated peak autumn and spring abundances of 187 and 210 birds were estimated. During the autumn and spring, peak numbers occurred in the 'control' survey area whilst in the winter peak numbers occurred in the proposed development area (Table 4-54 and Figure 4-52).

Table 4-54: Seasonal estimates of density and abundance of Common gulls in the proposed EOWDC and 'control' areas.

Season	Density Estimate (km^2)	SE	Estimated Abundance	SE	No. Observations
EOWDC - Winter	3.300	1.071	168	54.4	47
Control- Winter	0.832	0.239	42	12.1	24
EOWDC - Spring	0.535	0.529	27	26.9	9
Control- Spring	3.673	2.193	187	111.4	16
EOWDC - Summer	0.000	0.000	0	0.0	0
Control - Summer	0.000	0.000	0	0.0	0
EOWDC- Autumn	1.365	0.630	69	32.0	15
Control - Autumn	2.510	1.772	128	90.0	9

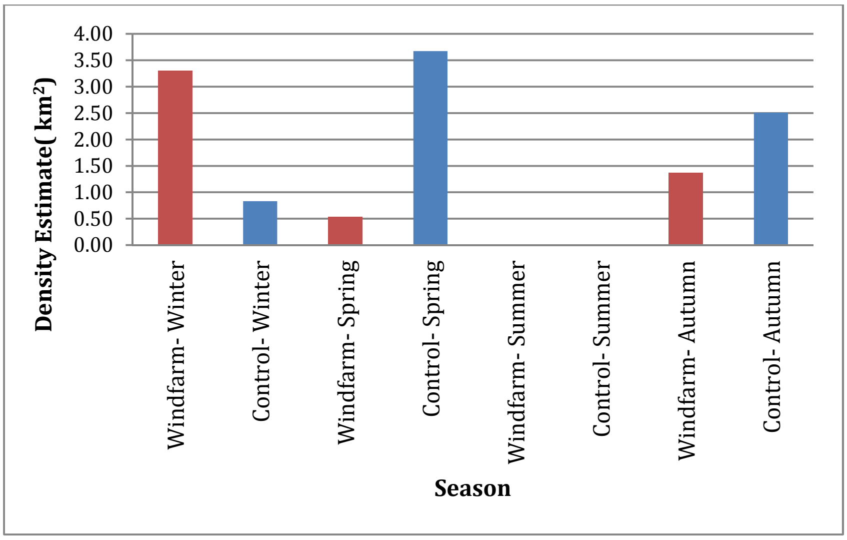


Figure 4-52: Seasonal estimates of density (+/- SE) of Common Gulls in the proposed EOWDC and 'control' areas – Year 1

Abundance estimates and density abundance for common gull for Year 2 using Distance sampling on a monthly and seasonal basis estimate occurred a peak number of common gulls during January and February with an estimated 177 and 129 common gulls recorded (Figure 4-53 and Figure 4-54) (SMRU 2011c).

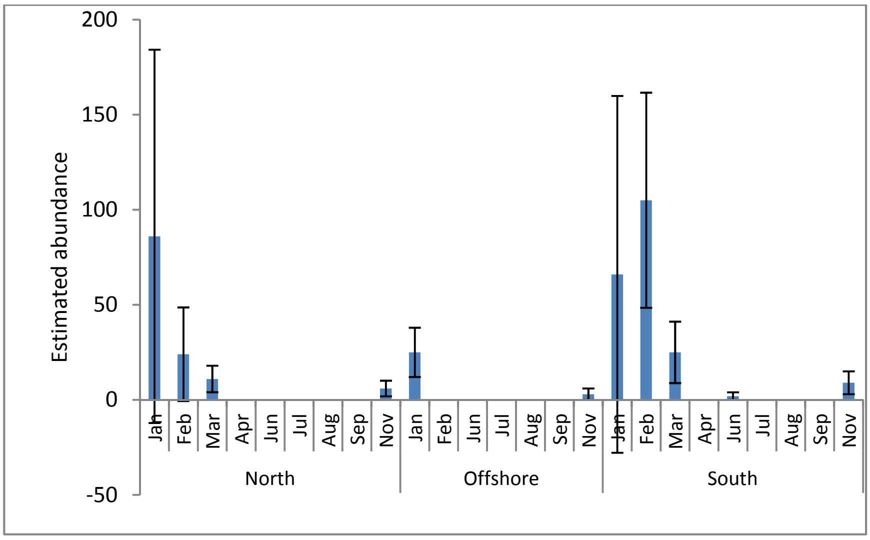


Figure 4-53: Monthly abundance estimates ± CV for common gull in each study strata for Year 2 surveys.

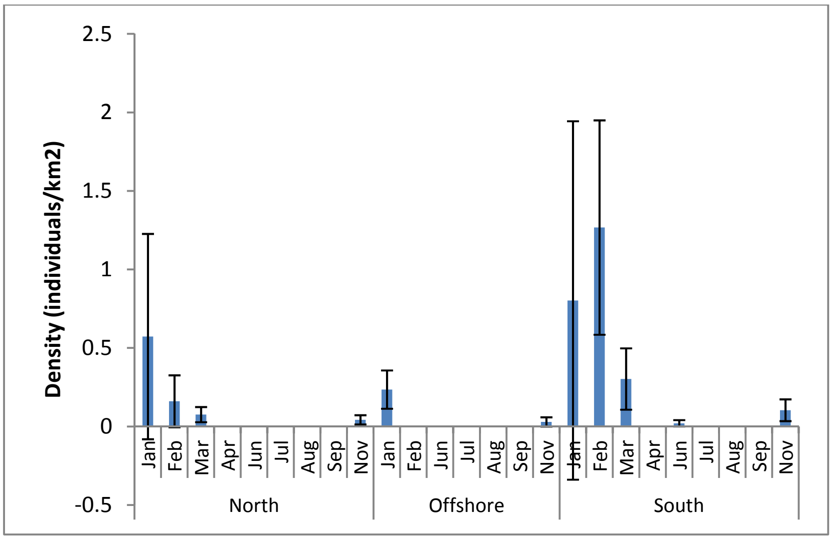


Figure 4-54: Monthly density estimates (individuals/km^2) ± CV for common gull in each study strata for Year 2 surveys.

Vantage Point surveys

In Aberdeen Bay common gulls were recorded throughout the year with peak numbers during periods of passage when up to 130 birds per hour passed Balmedie in April 2007, 150 birds per hour in February 2008 and up to 60 birds per hour passing during August 2006 (Alba Ecology 2008a,b; EnviroCentre 2007). The majority of sightings were within 0-2 km of the coast with up to 50% of birds flying between 30-150 m.

Bird Detection Radar

A total of 490 common gulls were observed during the radar studies undertaken at Drums and Easter Hatton during October 2005. A total of 80% of sightings were made at Drums (Walls *et al.* 2006).

In April 2007, 336 common gulls were recorded over a seventeen day period at Blackdog at a rate of 6.5 birds per hour. The mean flock size was of six birds but a maximum flock of 68 was recorded (Simms *et al.* 2007).

4.26.3 Summary of Results

Common gulls were recorded throughout the year with peak numbers during early spring and autumn with peak counts of up to 150 birds per hour in February 2008. There were relatively few sightings of common gull from boat-based surveys during the breeding season (Appendix B).

Of those recorded in flight up to 50% were recorded flying between 30 m and 150 m.

No counts of common gull from any of the surveys within Aberdeen Bay were of national importance.

4.26.4 Species Sensitivities

Qualifying species

There are no SPAs in the region for which common gull is a qualifying species.

Flight height

Observations from boat-based surveys recorded 30.75% of flight at above 25 m (n=618). Data from onshore surveys recorded up to 30% of flight heights as being above 30 m.

Elsewhere, out of 10,168 recorded flight heights for common gull modelling predicts approximately 23% of flights at above 20 m (Cook *et al*. 2012).

Collision risk

Data from site specific monitoring and other data sources indicate that common gulls are widespread throughout Aberdeen Bay, particularly between October and March (Appendix B).

In order to determine potential effects of collision on common gull a collision risk assessment has been undertaken (Appendix A1).

The CRM predicts between 5 and 63 common gulls may collide with the proposed development depending on the avoidance rate selected and use of site specific or generic modelled data (Table 4-55).

Table 4-55: Common gull predicted collision mortalities per year.

Rochdale	Flight height data source	Avoidance rate (%)			
		95.0	98.0	99.0	99.5
Original	EOWDC	63 +/- 89.32	25 +/- 35.74	13 +/- 17.87	6 +/- 8.94
	Generic	47 +/- 65.91	19 +/- 26.37	9 +/- 13.19	5 +/- 6.59
Revised	EOWDC	51 +/- 71.58	20 +/- 28.64	10 +/- 14.32	5 +/- 7.16
	Generic	37 +/- 52.82	15 +/- 21.13	7 +/- 10.57	4 +/- 5.28

Based on the precautionary avoidance rate of 98%, it is predicted that less than 20 collisions per year may occur.

During the breeding season (April to August) no common gulls are predicted to collide with the proposed development with peak risk of collision in October when an estimated 12 common gulls may collide (Appendix A).

The regional coastal breeding population comprising of roof nesting birds in and around Aberdeen is estimated to be 1,240 breeding adults (Calladine *et al*. 2006) which may have an annual mortality of 174 birds per year and a 1% baseline mortality rate of two birds per year. During the breeding season it is predicted that there will be no collisions between April and August and therefore there will not be any significant impact on the breeding population during this period (Appendix A). Outwith the breeding season collision mortality is predicted to increase but the overall numbers at risk are relatively low and the potential impacts temporally long-term and of negligible magnitude and significance.

Studies relating to other species of Gull (e.g. Everaert and Kuijken 2007) have reported avoidance rates at greater than 99% and the densities used to calculate the potential number of mortalities is based on the highest densities recorded from site specific boat-based surveys. Therefore, it may be predicted that the number of common gulls at risk of collision will be lower than has been indicated by the collision risk modelling and may be half those predicted using the precautionary 98% avoidance rate. However, post-construction monitoring also indicates that common gulls may be attracted to offshore wind farms and consequently the number of birds present in the proposed development area may increase following construction and therefore there could be an increase in the number of collisions (Vanermen *et al*. 2011).

Barrier effect

Post construction monitoring from existing offshore wind farms indicate that Gulls, including common gulls may enter offshore wind farms and there is not a significant barrier effect (Zucco *et al.* 2006). However, should it occur, the relatively short increase in distance, estimated to be at most 3.2 km, that common gulls may have to travel in order to fly around the proposed EOWDC is predicted not to be significant in terms of increased energetic expenditure. Site specific surveys have not recorded any regular passage of common gulls across Aberdeen Bay and the peak numbers present during the migration periods indicate that the birds that do occur in the proposed development area may be migrating to and from breeding or wintering grounds. Consequently, the potential impact from the barrier effect is predicted to be temporally long-term and of negligible magnitude and significance.

Displacement

There are no reports on whether there is a displacement effect to common gulls (e.g. Zucco *et al*. 2006). However, no displacement effects have been reported for other similar Gull species and it is predicted that there will not be any displacement effect from the proposed development. Should it occur, its significance is predicted to be negligible as relatively low numbers of common gulls were recorded within the proposed development area but they occurred widely across Aberdeen Bay, indicating that should birds be displaced they will be able to find other suitable areas to which to forage. It is predicted that any displacement impacts, should they occur, will be temporally long-term and of negligible magnitude and significance.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on common gulls.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth. The only data available are from the Beatrice Demonstrator Project that did not record any common gulls over a period of 12 months pre-construction surveys and the Beatrice offshore wind farm, which recorded 8 common gulls (BOWL 2012, Talisman 2005). Data are not available from other proposed offshore wind farms. However, the locations of the proposed developments are further offshore and common gulls are not predicted to occur in significant numbers within these areas. Consequently, it is predicted that the risk of any cumulative or in-combination effects is low and the magnitude and significance negligible.

Table 4-56: Summary of significance of potential impact on common gull.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Low	Negligible	Medium	Negligible
Operation	Collision	Medium	Negligible	Long-term	Negligible
	Displacement	Low	Negligible	Long-term	Negligible
	Barrier	Low	Negligible	Long-term	Negligible
Decommissioning	Displacement	Low	Negligible	Medium	Negligible
Cumulative	All	Medium	Negligible	Long-term	Negligible

4.26.5 Conclusions

Habitats Appraisal

There are no SPAs within the region for which common gulls are listed as a qualifying species.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental effect arising from the proposed development on common gulls.

4.27 Lesser black-backed gull (*Larus fuscus*)

4.27.1 Protection and Conservation Status

The Lesser-black backed gull is listed in Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.27.2 Background

Lesser black-backed gull		
GB population	Breeding: 110,000 prs Winter: 118 – 131,000 ind.	BTO 2011
Scottish population	Breeding: 25,000 AoN Winter: 200 – 600 ind.	Forrester *et al*. 2007
International threshold	5,500 ind.	Calbrade *et al*. 2008
GB threshold	500 ind.	Calbrade *et al* 2008
Designated east coast sites where species is a noted feature	Forth Islands 2,920 prs	JNCC 2011a
European population estimate	Breeding 300,000 – 350,000 pairs Wintering – >130,000	Birdlife 2004
European population trend	Status 'secure' Trend 'large increase'	Birdlife 2004
World population	910,000 – 1,100,000 'adults'	Birdlife 2011

The lesser black-backed gull breeds in colonies located around the UK coastline. There are approximately 110,000 breeding pairs in the UK, of which 21% occur in Scotland. In Scotland this species is principally a summer migrant with a small but increasing wintering population (Forrester *et al*. 2007; NESBR).

Lesser black-backed gulls occur in both inshore and offshore waters, often further offshore than many other species of gull during the breeding season (BirdLife International 2012). They are both scavengers and, offshore, often associate with fishing vessels (Camphuysen 1995).

In North-east Scotland the species is predominantly a summer migrant and is scarce during the winter months (NESBR). During the breeding season lesser-black backed gulls are primarily coastal with an estimated 200 - 300 pairs nesting in the region. Since the late 1980's the number of lesser black-backed gulls nesting on roof tops in Aberdeen has increased (Bourne 2011c).

At Peterhead passage of lesser black-backed gulls occurred between March and May with a peak in April and no records between October and February. The majority of sightings were within close proximity of the coast (Innes 1994).

Boat-based surveys

Three sightings totalling six lesser black-backed gulls were made during boat-based surveys undertaken between February 2007 and January 2008 (IECS 2008). A further 60 lesser black-backed gulls were recorded throughout the surveyed area between August 2010 and August 2011.

The seasonal distribution and encounter rates indicate peak numbers in Aberdeen bay occur during September with relatively low numbers present between February and August. There were no sightings of lesser black-backed gull from between October and January.

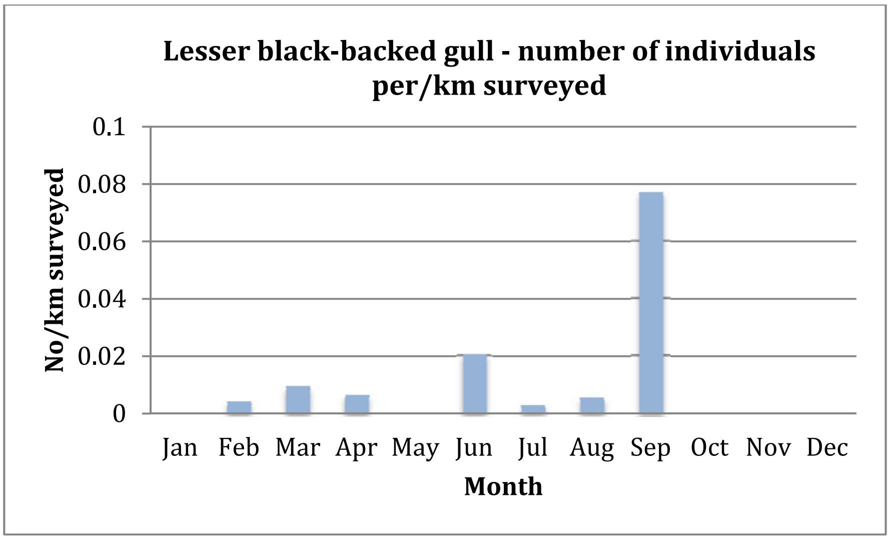


Figure 4-55: Encounter rates of lesser black-backed gull in Aberdeen Bay from two years of boat-based surveys.

Vantage Point surveys

Lesser black-backed gulls were recorded in relatively low numbers at all vantage point sites between April and September. Peak counts occurred in June and July with up to two birds per hour recorded. Although lesser black-backed gulls were recorded out to 3 km from the shore, the vast majority were within 0 - 2 km from the shore. 40% of all flights were within the 30 - 150 m height band. During the winter period, lesser black-backed gulls were scarce in Aberdeen Bay with nineteen records between October 2007 and March 2008 (Alba Ecology 2008b).

Bird Detection Radar

Six lesser black-backed gulls were observed during the radar studies undertaken in October 2005 and three at Blackdog during April 2007 (Walls *et al*. 2006, Simms *et al.* 2007).

4.27.3 Summary of Results

Lesser black-backed gulls were recorded in relatively low numbers between February and September from boat-based surveys and small numbers from land-based observations. Of those for which flight height was recorded, 40% from land-based observation were within 30 – 150 m of the sea surface.

The majority of sightings were within 2 km of the coast with relatively few records beyond 2 km from the shore.

No counts of lesser black-backed gull from any of the surveys within Aberdeen Bay were of national importance.

4.27.4 Species Sensitivities

Qualifying species

The only SPA in the region for which lesser black-backed gull is a qualifying species is Forth Islands SPA where 2,920 pairs nest.

Flight height

Observations of flight altitudes from boat-based surveys indicated that 94% of all flights were below 25 m, with 6% at between 25 m and 200 m. Data from vantage point surveys recorded 40% of lesser black-backed gulls as flying between 30 m and 150 m.

Elsewhere, based on 35,114 recorded flight altitudes for lesser black-backed gull, modelling predicts approximately 27% of flights at greater than 20 m (Cook *et al*. 2012).

Collision risk

Data obtained from boat-based and land-based surveys recorded relatively few lesser black-backed gulls nearly all within 2 km of the coast. Data from coastal wind farms have recorded relatively low avoidance behaviour towards wind turbines by lesser black-backed gulls and they are known to collide with turbines. However, as nearly all sightings of lesser black-backed gull were within 2 km of the coast and therefore not at risk of collision with the proposed development and overall there were relatively few sightings of lesser black-backed gulls from boat-based surveys in the proposed development area, it is considered that although they may be at collision risk the frequency of the occurrence is low.

Although lesser black-backed gulls have been reported to forage up to 181 km from their breeding colonies (Thaxter *et al* 2012), tagging studies have indicated maximum foraging range for breeding adults of 107.5 km (Thaxter *et al*. 2012). Therefore, although those from the Forth Islands SPA may be at risk of collision with the proposed development, the majority of foraging trips are predicted to be considerably smaller and therefore lesser black-backed gulls from the Forth Island SPA will not be at significant risk of collision (Camphuysen 1995; Ens *et al.* 2008). It is concluded that the potential impacts will be temporally long-term and of negligible magnitude and minor significance.

Barrier effect

Data from post-construction monitoring studies undertaken in Denmark and Sweden indicate that lesser black backed gulls are generally not affected by offshore wind turbines and do not avoid entering wind farms. Consequently, there is not thought to be a significant barrier effect (Zucco *et al*. 2006, Leopold *et al*. 2011). Any impacts, should they occur, will be negligible magnitude and significance.

Displacement

Lesser black-backed gulls have been recorded entering areas of constructed offshore wind farms and no displacement effect has been recorded at some sites, e.g. Thornton Bank; whilst at other avoidance behaviour has been recorded, e.g. Bligh Bank (Vanermen *et al.* 2011).

Very few lesser black-backed gulls were recorded within the area of the proposed development and results from boat-based or land-based surveys suggest that the proposed development area is not extensively used by lesser black-backed gulls in preference to other areas in Aberdeen Bay. The majority of sightings were within 2 km of the coast and therefore should lesser black-backed gulls be displaced they may be able to move elsewhere without a significant affect. The magnitude of the impact and significnance of the effect will be negligible.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on lesser black-backed gulls.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth. The only data available are from the Beatrice Demonstrator Project, which did not record any lesser black-backed gulls over a period of 12 months pre-construction surveys and the Beatrice offshore wind farm, which recorded 15 lesser black-backed gulls over two years of surveys (BOWL 2012; Talisman 2005). Data from other proposed offshore wind farms are not currently available. Consequently, it is not possible to determine whether there will be a cumulative or in-combination impact arising from the proposed plans. However, based on the known behaviour of lesser black-backed gulls, they may occur in the areas of the proposed developments but are predicted to be in relatively low densities. It is therefore predicted that the risk of any cumulative or in-combination effects is low and the consequences temporally long-term and of negligible magnitude and minor significance.

Table 4-57: Summary of significance of potential impact on lesser black-backed gull.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Medium	Negligible	Medium	Negligible
Operation	Collision	Very High	Negligible	Long-term	Minor
	Displacement	Medium	Negligible	Long-term	Negligible
	Barrier	Medium	Negligible	Long-term	Negligible
Decommissioning	Displacement	Medium	Negligible	Medium	Negligible
Cumulative	All	Very High	Negligible	Long-term	Minor

4.27.5 Conclusions

Habitats Appraisal

The only SPA for which lesser black-backed gull is a qualifying species is the Forth Islands SPA, which is 124 km away. Although within the potential foraging range of lesser black-backed gull, the numbers recorded from boat-based and land-based surveys were low and consequently there will not be an adverse effect on the SPA.

Environmental Impact Assessment

Based on the relatively low numbers of lesser black-backed gulls recorded in Aberdeen Bay it is predicted that there will not be a significant effect arising from the proposed development on lesser black-backed gulls.

4.28 Herring gull (*Larus argentatus*)

4.28.1 Protection and Conservation Status

The herring gull is listed in Appendix III of the Bern Convention and is on the Red List of Species of Conservation Concern.

4.28.2 Background

Herring gull		
GB Population	Breeding: 131,000 pairs	BTO 2011
Scottish population	Breeding: 72,000 AoN Wintering: 91,000 ind.	Forrester *et al* 2007
International threshold	5,900 ind.	Calbrade *et al*. 2010
GB threshold	4,500 ind.	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	Buchan Ness to Collieston – 3,114 AoN (2007) Fowlsheugh – 214 AoN (2009) Troup Pennan and Lion's Heads – 1,687 prs	SNH 2011b JNCC 2011a
European population estimate	Breeding 764,000 – 1,400,000 prs Wintering – >800,000	Birdlife 2004
European population trend	Status 'secure' Trend 'overall increase'	Birdlife 2004
World population	2,700,000 – 5,700,000 'adults'	Birdlife 2011

Herring gulls are widespread around the British coasts with largest concentrations along rocky coastlines of northern and western Scotland and North-west England (JNCC 2012). Following breeding, there is a general southerly movement of herring gulls with breeding birds at any one area replaced by birds from more northerly colonies (Wernham *et al.* 2002). They are opportunistic feeders; scavenging and predating a wide range of foods. At sea, herring gulls forage extensively around fishing vessels (Camphuysen 1995).

In North-east Scotland the breeding population has decreased since the 1960's when 42,500 apparently occupied nests were recorded in the region to 15,000 in 2002. However, there have been increases in the number of urban nesting herring gulls with 3,500 pairs nesting in Aberdeen (Bourne 2011d).

Herring gulls occur throughout the year in North-east Scotland and a spring passage has been recorded past Peterhead between March and June and peak numbers occurring in July and August (Innes 1994).

Boat-based survey

Herring gulls were recorded throughout the year within Aberdeen Bay but there were distinct seasonal variations in the numbers present with relatively low numbers between November and March and a significant increase in the number of birds during the breeding season, particularly in June and July (Figure 4-56, Appendix B). Following breeding, the number of herring gulls decreased with just a few birds recorded offshore. Peak densities and population estimates within the wider proposed EOWDC development area mainly occurred during June and July with up to 456 birds recorded during July in Year 1 and 320 in July in Year 2 and densities of 3.86 birds/km^2 in April and 3.87 birds/km^2 during July Figure 4-56 to Figure 4-59).

Of those recorded in flight from boat-based surveys, 32% of herring gulls were flying above 25 m.

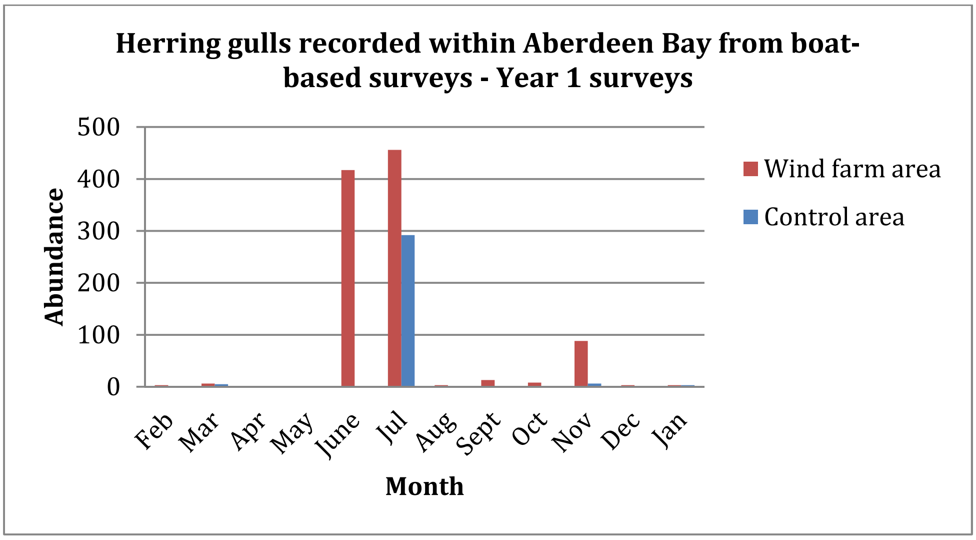


Figure 4-56: Herring gull monthly population estimates in proposed EOWDC and 'control' areas: Boat-based surveys 2007 – 2008.

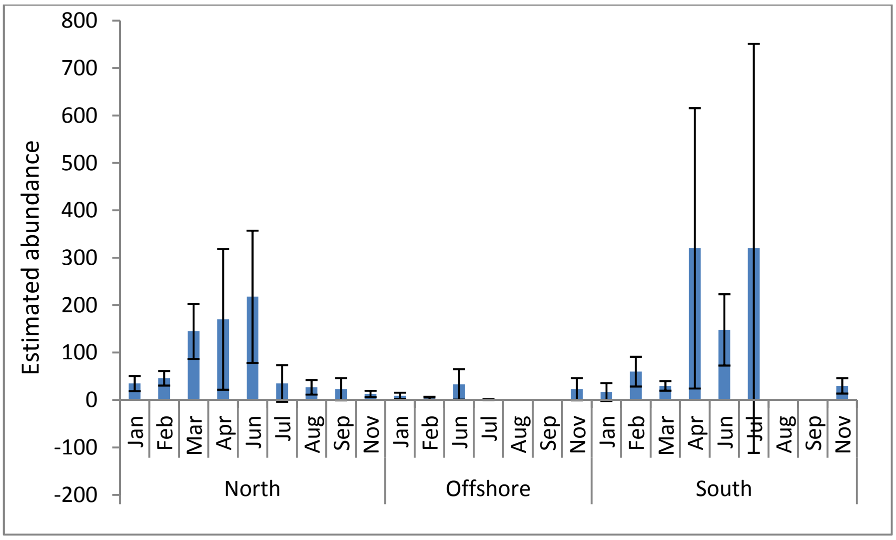


Figure 4-57: Monthly abundance estimates ± CV for herring gull in each study strata in 2010 and 2011.

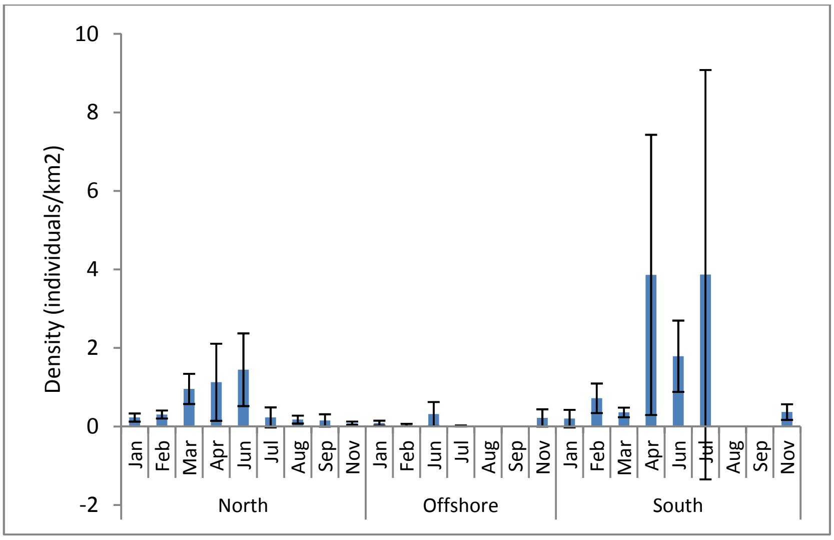


Figure 4-58: Monthly density estimates (individuals/km^2) ± CV for herring gull in each study strata in 2010 and 2011.

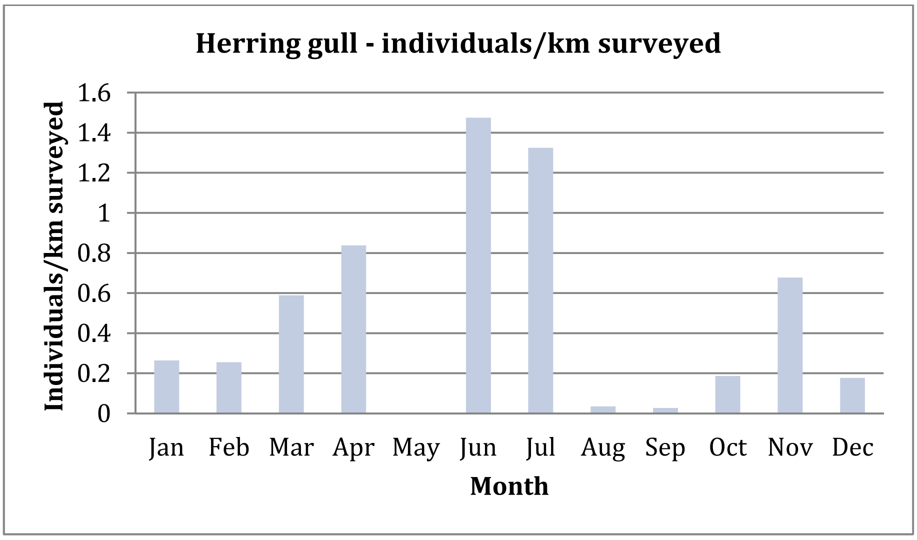


Figure 4-59: Encounter rates of herring gull in Aberdeen Bay based on two years of boat-based surveys.

Vantage Point surveys

Vantage point counts undertaken in Aberdeen Bay between April 2006 and March 2008 recorded herring gulls during every month and across all four survey sites. Peak numbers occurred during June when up to 240 birds per hour were recorded, with 50% of all records within the 30 - 150 m height band (Alba Ecology 2008a, EnviroCentre 2007). During the winter months, herring gulls were still regularly recorded with generally less than 100 birds per hour, with a peak of 180 birds per hour at the Donmouth in March 2008 (Alba Ecology 2008b). The majority of all sightings were within 2 km of the coast with considerably fewer sightings beyond 2 km (Figure 4-60).

Of those in flight, 48% of herring gulls were recorded from vantage point surveys as flying between 30 - 150 m.

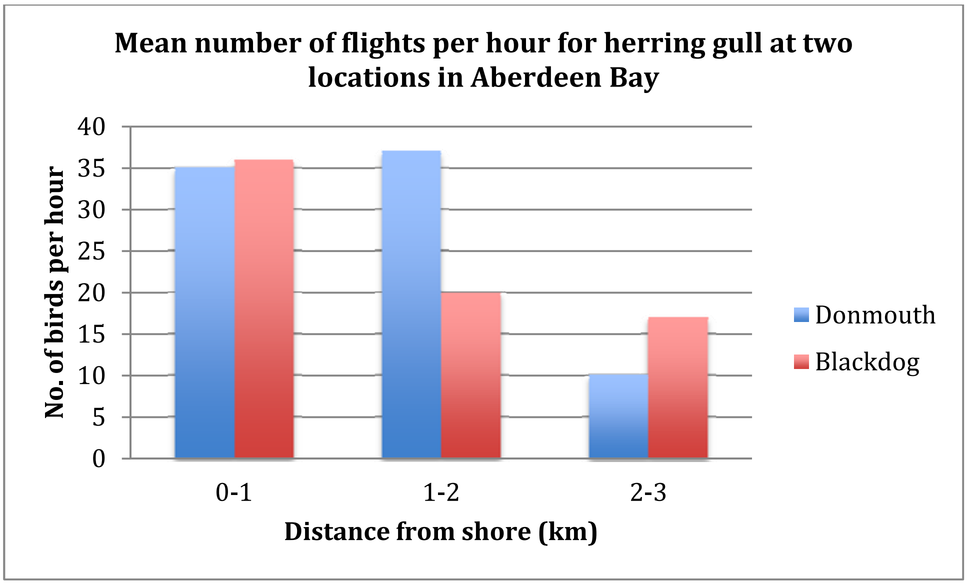


Figure 4-60: Mean number of herring gulls per hour passing two Vantage Points in Aberdeen Bay and their distance from shore.

Bird Detection Radar

Three hundred and eighty herring gulls were observed during the radar studies in October 2005. The majority of birds were recorded at Drums where 86% of all sightings occurred (Walls *et al*. 2006).

A total of 34 herring gulls were recorded during seventeen days of observations undertaken at Blackdog during April 2007 (Simms *et al.* 2007).

4.28.3 Summary of Results

Herring gulls were recorded throughout the year with peak numbers from boat-based surveys during June and July and relatively few records during other times of year. Land-based observations recorded higher numbers of herring gulls than the boat-based surveys in particular during the winter and spring periods when lower numbers were recorded offshore.

The majority of sightings were within 3 km of the coast with smaller numbers beyond 2 km from the shore. Of those recorded in flight from land based observations up to 48% were recorded flying between 30 m and 150 m.

No counts of herring gull from any of the surveys within Aberdeen Bay were of national importance.

4.28.4 Species Sensitivities

Qualifying species

Herring gull is a qualifying species for three SPAs that could potentially interact with the proposed development: Buchan Ness to Collieston Coast, Fowlsheugh and Troup Pennan and Lion's Heads.

Flight height

Flight altitude data obtained from boat-based surveys reported 32% of flights at above 25 m.

Elsewhere, based on 25,153 recorded flight altitudes for herring gull, modelling predicts 31% at greater than 20 m (Cook *et al*. 2012).

Collision risk

Results from site specific monitoring using boat-based and land-based surveys and other data sources (e.g. NESBR) indicate that herring gulls are widespread and frequent within Aberdeen Bay and with a distinct seasonal peak in occurrence during the summer months.

In order to determine potential effects of collision on herring gull a collision risk assessment has been undertaken (Appendix A1).

The CRM predicts between 6 and 64 herring gulls may collide with the proposed development depending on the avoidance rate selected and use of site specific or generic modelled data (Table 4-58).

Table 4-58: Herring gull predicted collision mortalities per year.

Rochdale	Flight height data source	Avoidance rate (%)			
		95.0	98.0	99.0	99.5
Original	EOWDC	64 +/- 65.01	26 +/- 26.01	13 +/- 13.01	6 +/- 6.50
	Generic	62 +/- 66.98	25 +/- 26.80	12 +/- 13.41	6 +/- 6.70
Revised	EOWDC	48 +/- 48.02	19 +/- 19.02	10 +/- 9.61	5 +/- 4.80
	Generic	49 +/- 46.26	18 +/- 18.51	9 +/- 9.26	5 +/- 4.63

Based on the precautionary avoidance rate of 98% it is predicted that up to 19 collisions per year may occur (Table 4-58).

Based on the regional SPA and Aberdeen City population of herring gulls of 14,802 individual adults and annual adult mortality rate of 12% (BTO 2011), the annual mortality rate will be 1,776 individuals and therefore the 1% baseline mortality rate will be 18 birds per year.

The number of herring gulls predicted to collide during the breeding season (April to August) using a 98% avoidance rate is 11 birds (Appendix A, Table 9-36).

To determine the potential impact on each the three SPAs identified as having between a low and high level of connectivity, the potential collision mortality is apportioned between the three sites based on the distance from the colony and the number of individuals within each colony. Included within this is the population of roof top nesting herring gulls in Aberdeen City, the closest colony to the proposed development but not an SPA.

Table 4-59: Predicted number of collisions based on 98% avoidance rate at each SPA with potential connectivity and Aberdeen City during the breeding season.

SPA colony	Herring gull		
	Distance to colony (km)	Number of collisions predicted (breeding season)	% of breeding population
Aberdeen City	*c*. 3.0	8	0.01
Buchan Ness to Collieston	9.5	2	0.04
Fowlsheugh	32	1	0.2
Troup Pennan and Lion's Heads	74.3	<1	<0.02

Note Aberdeen City is not an SPA.

The Buchan Ness to Collieston Coast SPA lies approximately 9.5 km away from the proposed development and, based on the latest available counts in 2007, holds approximately 6,228 breeding herring gulls. The colony will therefore have an estimated annual mortality of approximately 747 birds and 1% baseline mortality of 7.5 adults per year. The results from the collision risk modelling predict a mortality of 2 herring gulls during the breeding season, which is below 0.1% of the breeding population.

The Fowlsheugh SPA lies 32 km away from the proposed development and holds 214 breeding pairs of herring gull based on latest counts. Therefore, the annual mortality rate from this colony is 51 birds per year. Based on the results from the collision risk modelling it is predicted that, at most, one herring gull, 0.2% of the breeding population, will be at risk of collision each breeding season.

Troup Pennan and Lion's Heads SPA lies 74.3 km away and is considered to have a low level of connectivity. The collision risk modelling predicts less than 1 collision per year.

The number of herring gulls recorded within the proposed development area was lower than areas to the south or north of the proposed EOWDC (Appendix B) and consequently, the results from the modelling is derived from higher numbers of herring gulls than were recorded from boat-based surveys from within the development area. Consequently, the number of collisions that will occur will be lower than the modelling predicts.

Evidence of avoidance rates greater than 99% have been reported from other wind farms (including onshore) where the chances of a collision by herring gulls flying at rotor height have been reported as being between 1 in 695 and 1 in 2,100 and for herring gulls flying at all heights of between 1 in 1,119 and 1 in 3,700 (Everaert and Kuijken 2007). By using a more likely, but less precautionary, avoidance rate of 99% then the number of herring gulls predicted to collide is approximately halved. Furthermore, the modelling does not separate between non-breeding immature herring gulls and breeding adults and some collision mortality will be with non-breeding immature birds and therefore not associated with breeding populations at SPAs.

It is predicted that the number of collisions by herring gulls during the breeding season from each of the SPAs will be less than one per year.

The overall numbers of collisions will be temporally long-term and of negligible magnitude and of minor significance and not cause an adverse effect or likely significant impact.

Barrier effect

Data from post-construction monitoring studies undertaken in Denmark and Sweden indicate that although herring gulls may make some avoidance response they are generally not affected by offshore wind turbines and do not avoid entering wind farms. Consequently, there is not thought to be a significant barrier effect on herring gulls from the proposed development (Zucco *et al*. 2006). Any impacts, should they occur, will be negligible in magnitude and significance.

Displacement

There have been no reported displacement effects on herring gulls from offshore wind farms but some evidence of an increase in numbers within the constructed offshore wind farm areas (Zucco *et al.* 2006). No displacement is predicted. Any impacts, should they occur, will be negligible in magnitude and significance.

Cumulative and in-combination

The main activity within Aberdeen Bay that may cause a cumulative effect is the ongoing city wide Gull control programme undertaken by Aberdeen Council during the nesting and fledgling season aimed at reducing the number of gulls, particularly herring gulls, in

Aberdeen City. The numbers of nests and eggs destroyed each year are unknown but may be relatively high (ACC 2009).

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth. The only data available are from the Beatrice Demonstrator Project, which recorded 193 herring gulls over a period of 12 months of pre-construction surveys, and the Beatrice offshore wind farm, which recorded 415 herring gulls over two years of surveys (BOWL 2012; Talisman 2005). Data from other planned offshore wind farms are not available. Consequently, it is not possible to determine whether there will be a cumulative or in-combination impact arising from all the proposed plans. However, based on the predicted number of collisions arising from the proposed development the risk of any cumulative or in-combination effects is low and should there be any effects, the magnitude negligible and of minor significance.

Table 4-60: Summary of significance of potential impacts on herring gull.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Medium	Negligible	Medium	Negligible
Operation	Collision	Very High	Negligible	Long-term	Minor
	Displacement	Medium	Negligible	Long-term	Negligible
	Barrier	Medium	Negligible	Long-term	Negligible
Decommissioning	Displacement	Medium	Negligible	Medium	Negligible
Cumulative	All	Very High	Negligible	Long-term	Minor

4.28.5 Conclusions

Habitats Appraisal

There are three SPAs for which herring gulls are a qualifying species in the region. The predicted numbers of collisions at the three sites during the breeding season are predicted to be relatively low and there will not be an adverse effect on either Buchan Ness to Collieston Coast SPA, Troup, Pennan and Lion's Head SPA or Fowlsheugh SPA. It is predicted that actual avoidance rates may be higher than assessed and the number of herring gulls at risk of collision potentially lower than modelled.

Environmental Impact Assessment

Based on the results from collision risk modelling undertaken and the potential number of herring gulls, which may collide with the proposed development and the likely foraging ranges of the herring gulls present in the region it is predicted that there will not be a significant effect arising from the proposed development on regional population of herring gulls.

4.29 Great black-backed gull (*Larus marinus*)

4.29.1 Protection and Conservation Status

The great-black backed gull is listed in Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.29.2 Background

Great black-backed gull		
GB population	Breeding: 17,000 prs. Winter: 71 – 81,000 ind.	Mitchell *et al.* 2004 BTO 2011
Scottish population	Breeding: 14,800 AoN Winter: 7,500 – 10,000 ind.	Forrester *et al*. 2007
International threshold	4,400 ind.	Calbrade *et al 2010*
GB threshold	400 ind.	Calbrade *et al.* 2010
Designated east coast sites where species is a noted feature	None	SNH 2011b JNCC 2011a
European population estimate	Breeding 110,000 – 180,000 pairs Wintering – >150,000	Birdlife 2004
European population trend	Status 'secure' Trend 'large increase'	Birdlife 2004
World population	540 – 750,000 'adults'	Birdlife 2011

The great black-backed gull is Britain's largest breeding gull. It occurs widely around UK coast, particularly in areas of rocky coastlines. It is an opportunistic feeder being a predator, scavenger and food pirate and frequently occurs around fishing vessels (Buckley 1990; Farmer and Leonard 2011).

The UK population is approximately 17,000 pairs of which 14,800 are in Scotland and of those, the majority are in the north and west of Scotland (Forrester *et al*. 2007). In North-east Scotland the great black-backed gull is a scarce breeding species with between 80 - 90 pairs (Bourne 2011e). The UK population is largely sedentary with some localised winter movements and migrants from northern Europe arriving during the winter (Wernham 2002).

In North-east Scotland great black-backed gulls occur around all coasts with numbers increasing from July and August onwards. No obvious passage of birds was detected at Peterhead during the ten years of observations undertaken between 1978 and 1988 (Innes 1994).

Boat-based surveys

Great black-backed gulls were recorded widely across Aberdeen Bay; predominantly within 1 to 3 km form the coast, throughout the year in relatively low numbers. Their distribution throughout the year was mainly coastal with birds recorded along the entire coastline. In Year 1 very few great black-backed gulls were recorded within the proposed development area but in Year 2 there was an increase in the numbers recorded (Appendix B).

In Year 1 peak counts from boat-based surveys were during June and July where as in Year 2 peak counts occurred in August with a total of 71 great black-backed gulls recorded. However, combined, the encounter rates/km surveyed were highest during the winter period (Figure 4-61) (SMRU 2011c).

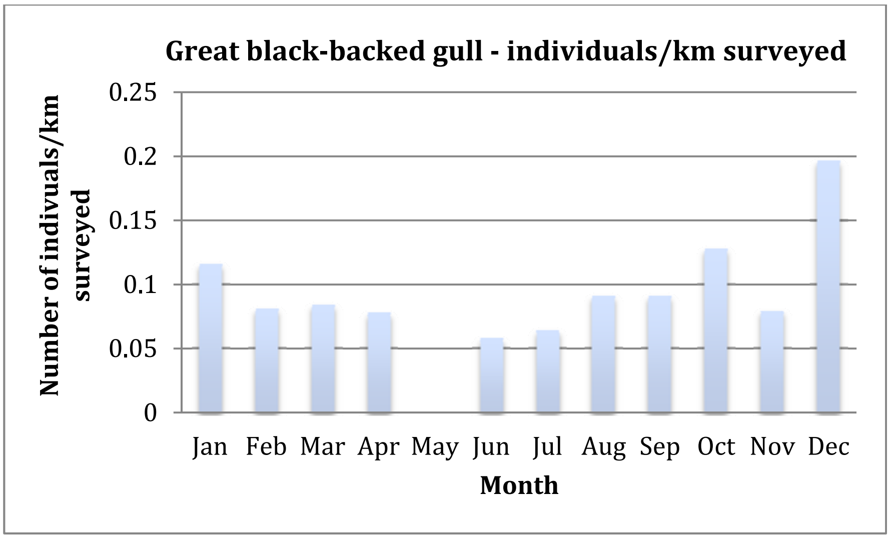


Figure 4-61: Encounter rates of great black-backed gull in Aberdeen Bay from two years of boat-based surveys

Vantage Point surveys

Great black-backed gulls were recorded in Aberdeen Bay throughout the year with peak counts of up to 15 birds per hour in June 2006 and eight birds per hour in August 2007 (Alba Ecology 2008a, EnviroCentre 2007). Relatively low numbers of six or less birds per hour were recorded during the rest of the year (EnviroCenter 2007, Alba Ecology 2008b). Recorded flight heights of 'black-backed gulls' (both lesser and great-black-backed) indicate that 40% of all flights occur within 30-150 m from sea surface and the majority of flights are within 1 km of the coast.

Bird Detection Radar

A total of 41 great-black-backed gulls were recorded during radar studies in October 2005 (Walls *et al*. 2006) and one bird was recorded during 17 days of observations in April 2007 (Simms *et al.* 2007).

4.29.3 Summary of Results

Great black-backed gulls were recorded in relatively low numbers throughout the year. Peak counts occurred during the winter periods. Land-based observations also recorded a slight peak in numbers during June and August but not many more than during the winter period. Of those for which flight height was recorded from land, 40% were within 30 - 150 m of the sea surface.

The majority of sightings were within 1 km of the coast with relatively few records beyond 3 km from the shore.

No counts of great black-backed gull from any of the surveys within Aberdeen Bay were of national importance.

4.29.4 Species Sensitivities

Qualifying species

There are no SPAs in the region for which great black-backed gull is a qualifying species.

Flight height

Observations of flight altitudes from boat-based surveys recorded 41.46% of great black-backed gulls as flying between 25 m and 200 m.

Modelling on data from other offshore surveys predicts 35% of great black-backed gulls at risk of collision (n=8,911) (Cook *et al*. 2012).

Collision risk

Great black-backed gulls fly more frequently at rotor height than any other species of seabird recorded in Aberdeen Bay. There is also little evidence of great black-backed gulls avoiding wind farms (Zucco *et al*. 2006). Consequently, the great black-backed gull is considered to be highly sensitive to collision risk.

Data obtained from boat-based and land-based surveys recorded relatively few great black-backed gulls across Aberdeen Bay with the majority of sightings to the south and north of the proposed development area and nearly all sightings within 2 km of the coast.

Data from site specific monitoring using boat-based and land-based surveys and other data sources indicate that great black-backed gulls are widespread along the coast of Aberdeen Bay and occur within the proposed development area.

In order to determine potential effects of collision on great black-backed gull a collision risk assessment has been undertaken (Appendix A1).

The CRM predicts between 3 and 38 great black-backed gulls may collide with the proposed development depending on the avoidance rate selected and use of site specific or generic modelled data (Table 4-61).

Table 4-61: Great black-backed gull predicted collision mortalities per year.

Rochdale	Flight height data source	Avoidance rate (%)			
		95.0	98.0	99.0	99.5
Original	EOWDC	38 +/- 56.74	15 +/- 22.71	8 +/- 11.35	4 +/- 5.68
	Generic	32 +/- 47.97	13 +/- 19.20	6 +/- 9.60	3 +/- 4.80
Revised	EOWDC	30 +/- 44.58	12 +/- 17.84	6 +/- 8.92	3 +/- 4.46
	Generic	25 +/- 37.69	10 +/- 15.08	5 +/- 7.54	3 +/- 3.77

Based on the precautionary avoidance rate of 98% it is predicted that less than 12 collisions per year may occur.

There are no SPAs in the region for which great black-backed gull is a qualifying species with the nearest designated breeding colonies in Orkney. Although there are no data on the foraging ranges of great black-backed gulls based on known foraging ranges for other large gull species it is predicted that these breeding colonies are outwith the foraging range of breeding great black-backed gulls.

The regional population of great black-backed gull is between 80 - 80 pairs (Bourne 2011e). During the breeding season (April to August) it is estimated that a total of two great black-backed gulls may collide based on a 98% avoidance rate (Appendix A).

A proportion of birds at risk of collision will also be non-breeding immature and consequently the number of adults predicted to collide will be less than two per breeding season. The effect is predicted to temporally long-term and of negligible magnitude and significance.

Barrier effect

Data from post-construction monitoring studies undertaken in Denmark and Belgium indicate that there is no barrier effect on great black-backed gulls from constructed wind farms (Zucco *et al*. 2006; Zanermen *et al.* 2011). Any impacts, should they occur, will be negligible in magnitude and significance.

Displacement

Data from operating wind farms indicate that great black-backed gulls may be attracted to offshore wind farms and that there are no displacement effects (Zucco *et al*. 2006; Zanermen *et al.* 2011). Any impacts, should they occur, will be negligible in magnitude and significance.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause a cumulative impact on great black-backed gulls.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth. The only data available are from the Beatrice Demonstrator Project which recorded 424 great-black backed gulls and predicted six collisions per year and the proposed Beatrice offshore wind farm which recorded 502 great black-backed gulls and predicted between 302 and 604 collisions per year (BOWL 2012; Talisman 2005). Data from other planned offshore wind farms are not available. Consequently, it is not possible to determine whether there will be a cumulative impact arising from all the proposed plans.

Foraging ranges of great black-backed gulls during the breeding season is reported to be less than 10 km and therefore potential in-combination impacts arising from the proposed developments in the Moray Firth and Firth of Forth during the breeding season will not occur. Based on the location and scale of the proposed EOWDC development any cumulative impact will be relatively small and predicted to be of negligible magnitude and significance.

Table 4-62: Summary of significance of potential impacts on great black-backed gull.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Low	Negligible	Medium	Negligible
Operation	Collision	High	Negligible	Long-term	Negligible
	Displacement	Low	Negligible	Long-term	Negligible
	Barrier	Low	Negligible	Long-term	Negligible
Decommissioning	Displacement	Low	Negligible	Medium	Negligible
Cumulative	All	High	Negligible	Long-term	Negligible

4.29.5 Conclusions

Habitats Appraisal

There are no SPAs in the region for which great black-backed gull is a qualifying species.

Environmental Impact Assessment

Based on the low numbers of great black-backed gulls recorded and that most sightings were within 3 km from the coast and the modelled low numbers of collisions, it is predicted that there will not be a significant environmental effect arising from the proposed development on great black-backed gulls.

4.30 Little tern (*Sterna albifrons*)

4.30.1 Protection and Conservation Status

The Little tern is listed in Annex I of the Birds Directive, Schedule I of the Wildlife and Countryside Act, Appendix II of the Bonn Convention, Appendix II of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.30.2 Background

Little tern		
GB population	Breeding: 1,900 prs	Mitchell *et al* 2004
Scottish population	Breeding: 331 AoN	Forrester *et al.* 2007
International threshold	490 ind.	Calbrade *et al*. 2010
GB threshold	50 ind.	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	Ythan Estuary Sands of Forvie and Meikle Loch – 36 pairs (2009) Firth of Tay and Eden Estuary (0 pairs)	SNH 2011b JNCC 2011a
European population estimate	Breeding 35,000 – 55,000 Wintering – none	Birdlife 2004
European population trend	Status 'declining' Trend 'moderate decline'	Birdlife 2004
World population	190,000 – 410,000	Birdlife 2011

The little tern is the smallest of Britain's terns, nesting in small colonies along sand and shingle beaches where they often suffer from disturbance and predation (Mitchell *et al*. 2004).

They arrive from their West African wintering grounds from April onwards and depart in August and September. They feed on small fish, foraging mainly within 1 km from shore and rarely beyond 5 km (BirdLife International 2012).

In North-east Scotland only sixteen little terns were recorded during ten years of observations at Peterhead. All were recorded between May and August and were within a few hundred metres of the shore. Little terns breed in the region at the Ythan Estuary and occasionally at St Cyrus where they return from their wintering grounds at the end of April. The numbers nesting varies considerably across years with many years having only a few pairs and others occasionally over 70 pairs nesting. The number of young fledged also varies considerably with most years producing only a few young due to predation and weather. During years where nests fail early, birds may leave the region by the end of June and early July but in years where nesting has been successful birds may remain in the area through to August or early September (Drysdale 2011; Buckland, Bell and Picozzi 1990; NESBR).

Boat-based surveys

No little terns were recorded from any of the boat-based surveys undertaken over the two years within Aberdeen Bay.

Vantage Point surveys

No little terns were recorded from vantage point counts between May and August 2006 and only 11 during the same period in 2007 (Alba Ecology 2008a,b). The only sighting in 2006 was of six birds in September 2006 (EnviroCentre 2007). All sightings were within 1 - 2 km of the coast and flying below 30 m.

Bird Detection Radar

There were no records of little tern from surveys undertaken during the radar studies.

4.30.3 Summary of Results

Very few little terns were recorded from any of the surveys undertaken during the study. There were no sightings from boat-based surveys and only 17 little terns over two years of vantage point surveys undertaken between April 2006 and March 2008. All sightings were of birds flying below 30 m.

No counts of little tern from any of the surveys within Aberdeen Bay were of national importance.

4.30.4 Species Sensitivities

Qualifying species

The little tern is a qualifying species for the Ythan Estuary, Sands of Forvie and Meikle Loch SPA where 36 pairs nested in 2009 and Firth of Tay and Eden Estuary where they last bred in 2007 and now no pairs breed.

Flight height

The only records of little tern were from vantage point surveys, which recorded a total of 17 little terns, all of which were flying below 30 m.

Collision risk

Results from site specific monitoring using boat-based and land-based surveys and other data sources indicate that relatively few little terns occur in Aberdeen Bay and when they do they remain mainly within 2 km of the coast and below turbine height. Consequently, it is predicted that the risk of a collision by little tern with the proposed development is extremely low.

Little terns typically forage between 3 m - 8 m above the surface and are therefore at low risk of collision (ECON 2006). Collisions of turbines by little terns have been reported from Zeebrugge harbour where an array of turbines are lined along harbour wall across which little terns fly to and from their colonies (Everaert and Stienen 2006). There have been no other collisions reported from other offshore wind farms where little terns occur.

Based on the small number of little terns potentially occurring within the proposed development area and the low flight heights at which they typically forage it is predicted that the risk of collision is low and the potential effects temporally long-term and of negligible magnitude and minor significance.

Barrier effect

Post construction monitoring studies undertaken in UK and Belgium have shown that there is unlikely to be a barrier effect with little terns recorded foraging within operating wind farms and no significant avoidance behaviour (ECON 2008; Everaert and Stienen 2006). However, no little terns were recorded within the proposed development area and data from other studies indicate that little terns forage mainly within 1 km of the coast and less frequently out to 4 km (ECON 2008). Consequently, it is predicted that there will not be a barrier effect on little terns from the proposed development. Any impacts, should they occur, will be negligible in magnitude and significance.

Displacement

Studies undertaken in Belgium and the UK have not shown any displacement effect on little terns by constructed wind farms (ECON 2008, Everaert and Stienen 2006). Four years of intensive studies undertaken at Scroby Sands offshore wind farm reported that following construction there was a greater use of the area than there had been previously. This increase in use was thought to be due to the formation of a new sand bar within the wind farm, thus providing better foraging opportunities coupled with changes in prey distribution (ECON 2008). No little terns were recorded within the proposed development area and therefore it is predicted that there will be little, if any, displacement effect on little terns due to physical presence of the potential development.

Disturbance

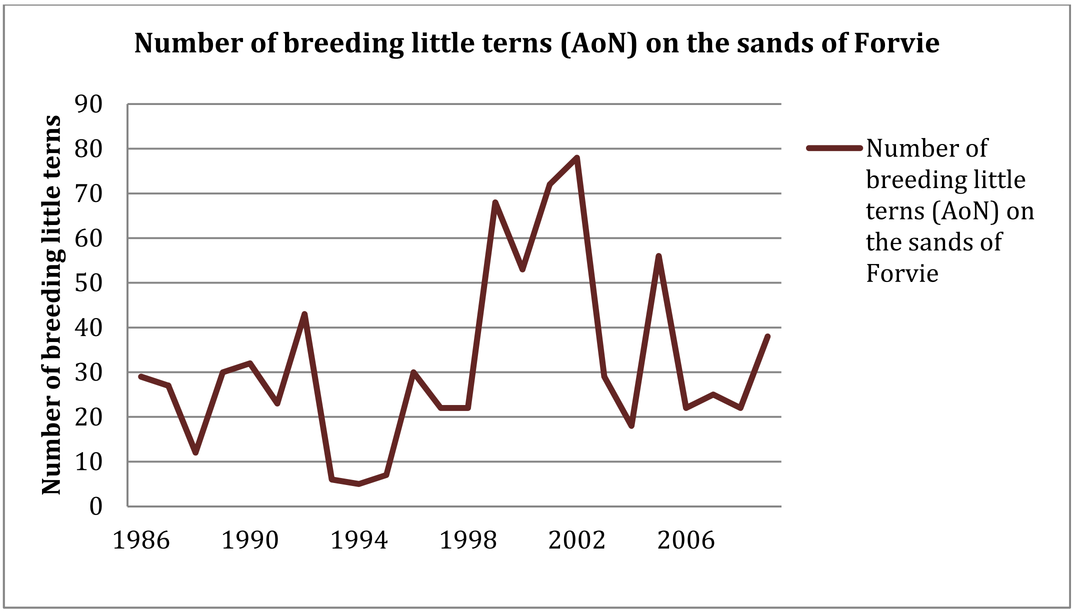
Little terns may not be impacted directly by activities associated with the proposed development. i.e. vessel movements, but results from monitoring undertaken at Scroby Sands indicate that there is the potential for a secondary impact should the prey of little terns be affected (ECON 2008). Little terns forage on small fish often, young clupeids. Monitoring undertaken at Scroby Sands, where 30 turbines were installed using piling techniques, recorded a reduction in the availability of young herring following the construction of a wind farm by pile-driving and a subsequent breeding failure of little terns (ECON 2008). The results indicated that little terns were able to compensate for the reduction in available prey by foraging further afield and changing prey items and there was not an overall population decline in the number of little terns in the area. However, the locations where the terns foraged and the sizes of different colonies varied with some increasing and others decreasing. Breeding success varied considerably across years and the size of the colonies changed significantly from one year to the next. The link between the decline in young herring and subsequent localised reduction in tern breeding success, being caused by the construction of the wind farm was not confirmed and the interaction between construction, little tern breeding success and fish availability was complex. However, an effect on little tern breeding success from the construction activities could not be discounted.

The significance of any potential effect depends on the scale of displacement and its duration. It also depends on whether other suitable foraging areas can be located.

The major source of potential disturbance on prey is predicted to arise during piling operations. The use of monopiles is predicted to be unlikely at the proposed EOWDC due to the seabed conditions. However, they may be required and up to four monopiled turbines may be installed. Each pile will take an estimated four to twelve hours to install, depending on ground conditions.

Although potential impacts upon prey are difficult to predict they are expected to be relatively short-term, as fish will start returning to the area once piling has ceased (see Appendix 9.1 and 9.2 of ES).

The numbers of breeding little terns breeding at the Sands of Forvie each year is highly variable as is their breeding success with many years where they fail to produce many, if any young (Figure 4-62). However, the population across the years has on average ranged been between 20 to 30 pairs with no obvious population decline even following periods of unsuccessful breeding. Consequently, a season without successful breeding, should it occur, is not predicted to have a significant impact on the little tern population.



AoN = Apparently Occupied Nest (Adapted from JNCC 2011b and NESBR)

Figure 4-62: Numbers of breeding little terns at the Sands of Forvie since 1986.

Based on the results from studies undertaken at Scroby Sands, there is the potential for a minor effect on little terns should the construction of the proposed development cause a significant decline in potential prey items of little terns during the breeding season. However, should it occur, it is predicted that the duration of impact would last no longer than one or two seasons, i.e. short to medium term as fish will be available the following season and the impact will be of negligible magnitude and of minor significance.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts.

Although there are other planned offshore wind farms, none are in areas where little terns will likely occur and therefore no cumulative or in-combination impacts are predicted.

Table 4-63: Summary of significance of potential impacts on little tern.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	Very High	Negligible	Medium	Minor
Operation	Collision	Very High	Negligible	Long-term	Minor
	Displacement	Very High	Negligible	Long-term	Minor
	Barrier	Medium	Negligible	Long-term	Negligible
Decommissioning	Displacement	Very High	Negligible	Medium	Minor
Cumulative	All	Very High	Negligible	Long-term	Minor

4.30.5 Conclusions

Habitats Appraisal

Based on the evidence from existing offshore wind farms indicating both a very low collision risk, little or no displacement and that there are not expected to be any barrier effects; there will not be any adverse effects on the SPA for which little tern is a qualifying species. However, should pile-driving be undertaken, there is the potential for an impact on the prey of little terns during the construction period. If this occurs there is the potential for a localised adverse effect during the construction period but thereafter breeding success would not be affected by the proposed development. Little terns regularly have unsuccessful breeding seasons and therefore the population can withstand one or two poor breeding seasons, should they occur, without having an adverse effect on the population.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there may be a potential minor effect arising from the proposed development on little tern. Although impacts arising from the possible reduction in the availability of suitable prey species during the breeding season could have a temporary impact it will not cause significant environmental effect.

4.31 Sandwich tern (*Sterna sandvicensis*)

4.31.1 Protection and Conservation Status

The Sandwich tern is listed in Annex I of the Birds Directive, Appendix II of the Bonn Convention, Appendix II of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.31.2 Background

Sandwich tern		
GB population	Breeding: 11,000 prs	Mitchell *et al* 2004
Scottish population	1,100 AoN	Forrester *et al*. 2007
International threshold	1,700 ind.	Calbrade *et al*. 2010
GB threshold	200 ind.	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	Ythan Estuary, Sands of Forvie and Meikle Loch: 645 prs. (2009) Loch of Strathbeg: 1 pr. (2010) Firth of Forth: 1,617 ind. (passage) Forth Islands: 0 prs (2010)	SNH 2011b JNCC 2011a
European population estimate	Breeding 82 – 130,000 prs. Wintering – unknown	Birdlife 2004
European population trend	Status 'depleted' Trend 'small decline'	Birdlife 2004
World population	490 – 640,000 ind.	Birdlife 2011

Sandwich terns are regular summer migrants to UK waters and breed at coastal colonies on undisturbed beaches. Sandwich terns show low levels of philopatry and regularly move colonies and so numbers at each colony can vary considerably across years (Snow and Perrins 1998).

Following breeding from Late June onwards there is post-fledging dispersal of Sandwich terns with birds moving between the coasts of Britain and neighbouring countries across the North Sea (Wernham *et al*. 2002).

Birds return to their breeding grounds during April and remain in the area until the autumn. The number of Terns breeding is highly variable and their success depends on the availability of suitable prey, predation and weather. Sandwich terns forage offshore for small fish species, particularly sandeels and clupeids (BirdLife International 2012). The distance that they forage varies depending on prey availability with distances of up to 70 km reported and a mean maximum of 42.3 km (BirdLife International 2012, Thaxter *et al.* 2012).

The British breeding population is approximately 11,000 pairs of which 1,100 pairs breed in Scotland (Forrester *et al*. 2007).

In North-east Scotland Sandwich terns breed at the Sands of Forvie where up to 1,800 pairs have bred, although recent counts have been lower. Up until 1999 there was also a colony at the Loch of Strathbeg with up to 923 breeding pairs in 1994, although there has been none there since 1999 (Figure 4-63) (NESBR).

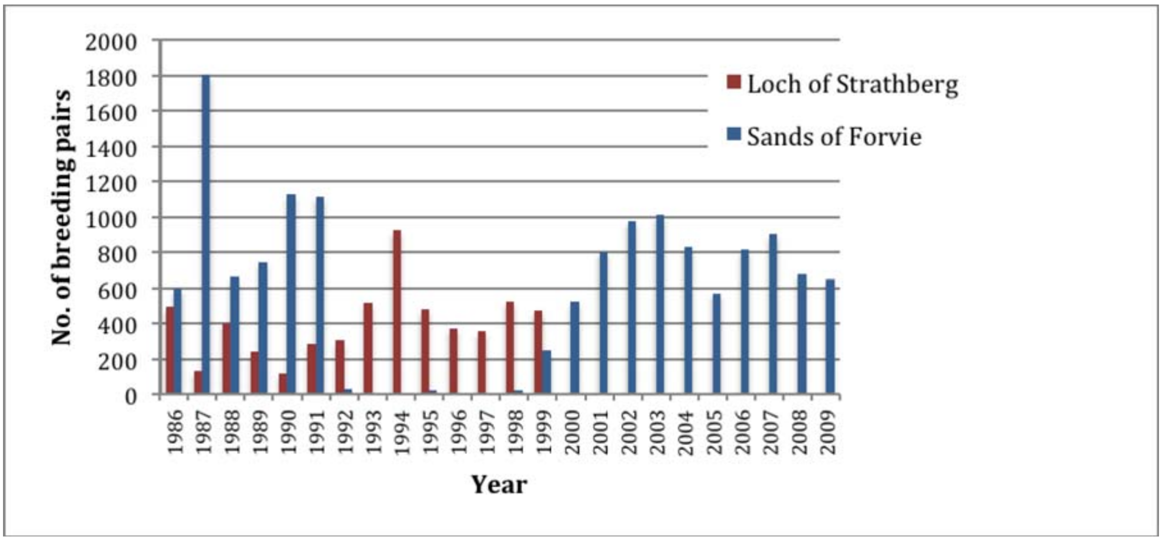


Figure 4-63: Numbers of breeding Sandwich terns at Loch of Strathbeg and Sands of Forvie between 1986 and 2009 (Source NESBR).

At Peterhead Sandwich terns have been recorded from March to October with peak numbers of up to three birds per hour in May and June.

Boat-based surveys

Although Sandwich terns are a common breeding species at the nearby Sands of Forvie with up to 670 breeding pairs during the periods boat-based surveys were undertaken in 2007/08 and 2010/11, relatively few were recorded from boat-based surveys undertaken in the proposed development area. Year 1 survey data recorded a total of five Sandwich terns within the proposed EOWDC boundary between April and July with all sightings in May and no more than three Sandwich Terns were recorded in the boundary area between August to March. Larger numbers were recorded in the area to the north of the proposed EOWDC area, where a total of 43 birds were recorded between May and July (Appendix B). Year 2 data recorded no Sandwich terns within the proposed development area with birds recorded across the rest of the surveyed area particularly during July (Figure 4-64 Appendix B). Combined year 1 and Year 2 data recorded highest encounter rates in May (Figure 4-65).

Nearly all sightings were of birds inshore and in water depths of less than 10 m (IECS 2008).

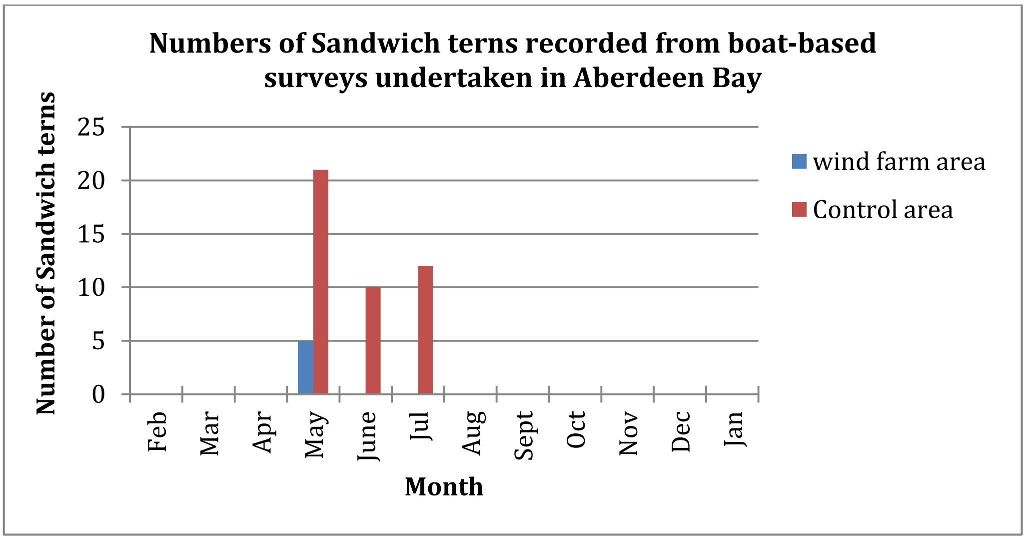


Figure 4-64: Sandwich tern monthly population estimates in proposed EOWDC and 'control' areas: Boat-based surveys 2007 – 2008.

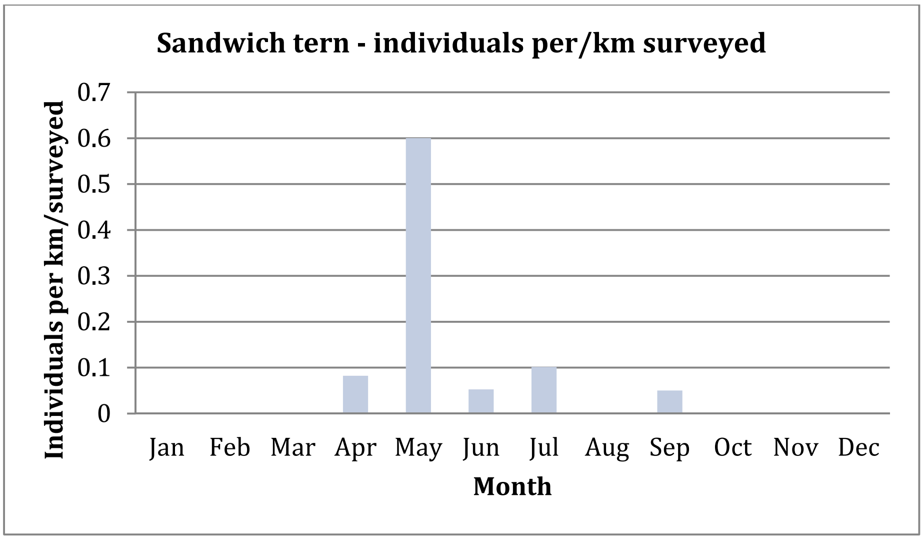


Figure 4-65: Encounter rates of Sandwich terns/km surveyed in Aberdeen Bay from two years of survey data.

Vantage Point surveys

Sandwich terns occur in Aberdeen Bay from March through to October with peak counts in May when up 100 birds per hour were recorded, and August 2007 when up to 300 birds per hour were recorded (Alba Ecology 2008a). A significant decrease in the number of birds was recorded in Aberdeen Bay during the breeding season of June and July with generally less than 50 birds per hour passing. Birds were recorded predominantly within the 0 - 2 km of the shore with few records beyond 2 km although this may, in part, be due to the reduced detectability of birds further offshore (Figure 4-66).

Of those for which flight height was recorded from onshore vantage point surveys at least 44% were recorded at between 30-150 m above the sea surface.

Bird Detection Radar

There were no Sandwich terns recorded during the radar surveys undertaken at Drums and Easter Hatton during October 2005. In April 2007 a total of 298 Sandwich terns were observed from Blackdog at a rate of nearly six birds per hour (Simms *et al*. 2007). All sightings were within 2 km from shore but this may, in part, be due to birds being missed further offshore from land-based observations.

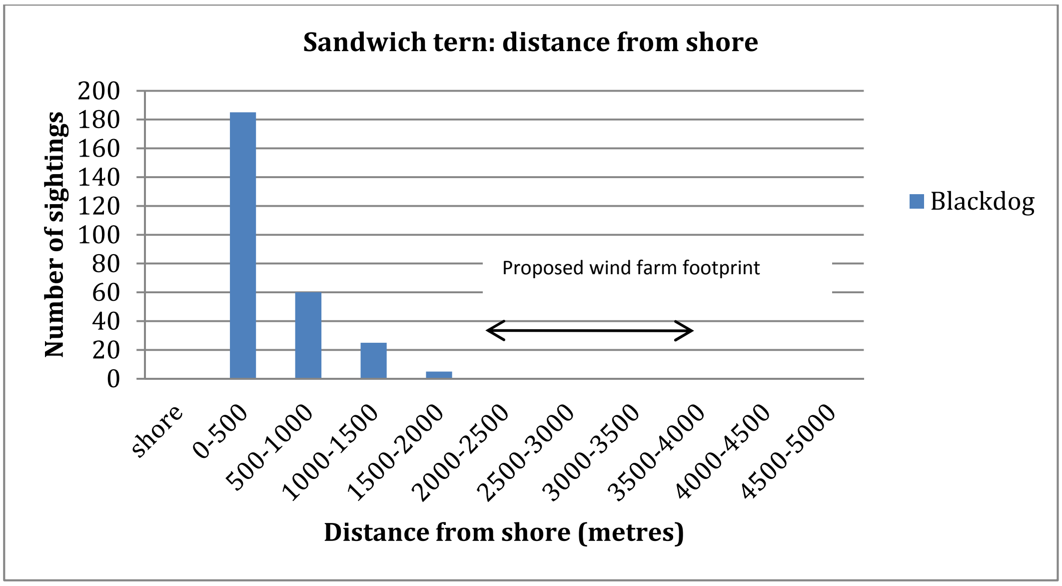


Figure 4-66: Distances from shore for Sandwich terns from Blackdog (April 2007).

4.31.3 Summary of Results

Relatively few Sandwich terns were recorded from boat-based surveys undertaken in Aberdeen Bay. A total of five birds were recorded in the proposed EWODC site during the breeding season in the first Years data and none during the Year 2 surveys. Peak numbers from boat-based surveys were in May and July with no records in August when relatively high numbers were recorded from land-based observations. The majority of sightings were within 500 m from shore with few sightings of birds beyond 2 km. Of those recorded in flight from shore, 44% of Sandwich terns were flying between 30 - 150 m but 5.7% were recorded flying above 25 m from boat-based surveys.

No counts of Sandwich tern from any of the surveys within Aberdeen Bay were of national importance.

4.31.4 Species Sensitivities

Qualifying species

The Sandwich tern is a qualifying species for the Ythan Estuary, Sands of Forvie and Meikle Loch SPA and Ramsar where 645 pairs nested in 2009; Loch of Strathbeg where 1 - 2 pairs nested in 2010, Forth Islands where no Sandwich terns now breed and the Firth of Forth which supports a post-breeding (passage) population of 1,617 individuals.

Flight height

Data from boat-based surveys recorded 5.7% of all flights at above 25 m, whereas 44% of those from vantage point counts were reported as being above 30 m. The reason for such a large discrepancy is unknown but may be due to birds foraging close to shore do so at a greater height than birds which may be transiting the site as opposed to foraging in the area. Elsewhere, modelling predicts approximately 7% of all flights as being above 20 m (n=33,392) (Cook *et al*. 2012).

Collision risk

In order to determine potential effects of collision on Sandwich tern a collision risk assessment has been undertaken (Appendix A1).

The CRM predicts between zero and two Sandwich terns may collide with the proposed development depending on the avoidance rate selected and use of site specific or generic modelled data (Table 4-64).

Table 4-64: Sandwich tern predicted collision mortalities per year.

Rochdale	Flight height data source	Avoidance rate (%)			
		95.0	98.0	99.0	99.5
Original	EOWDC	1 +/- 1.29	0 +/- 0.51	0 +/- 0.26	0 +/- 0.13
	Generic	2 +/- 3.39	1 +/- 1.36	0 +/- 0.68	0 +/- 0.34
Revised	EOWDC	1 +/- 0.89	0 +/- 0.36	0 +/- 0.18	0 +/- 0.09
	Generic	1 +/- 0.80	0 +/- 0.32	0 +/- 0.16	0 +/- 0.08

The number of Sandwich terns predicted to collide is low based on either site specific data or modelled generic data.

Based on the precautionary avoidance rate of 98% it is predicted that a less than 1 collision per year may occur.

The annual mortality rate for Sandwich tern is 11% (BTO 2011).

Based on the regional SPA population of Sandwich tern of 645 breeding pairs the annual mortality rate will be 142 individuals and therefore the 1% baseline mortality rate is 1.4 birds per year. The results from the collision risk modelling predict a total of less than 1 bird per year may collide with the wind turbines.

Results from site specific monitoring using boat-based and land-based surveys and other data sources (e.g. NESBR) indicate that relatively few Sandwich terns occur in area of the proposed development with nearly all sightings within 2 km of the coast and the majority within 1 km. A total of five Sandwich terns were recorded from boat-based surveys in Year 1 and none in Year 2 within the proposed development area. The collision risk modelling is based on the highest numbers recorded from all boat-based surveys, and therefore over estimates the potential number of collisions.

Data from some existing wind farms have reported relatively high number of collisions of Sandwich tern with wind turbines (e.g. Everaert and Stienen 2006). However, they have also demonstrated high avoidance rates of nearly 99% or more. The number of collisions recorded at Zeebrugge was largely due to the high number of transits made by the Sandwich terns at the sites. The risk of collision by Sandwich terns flying at rotor height at Zeebrugge was 1 in 1,130 and for birds at all flight heights it was 1 in 16,819 (Everaert & Kuijken 2007). Further assessment of the Sandwich Tern data obtained from Zeebrugge indicates that the avoidance rate of Sandwich terns may be 98.83% (DECC 2012).

Sandwich terns were the only regularly recorded Tern at Nysted (Denmark), with 1,700 birds each autumn and *c*850 each spring and there were no reported collisions (Petersen *et al.* 2006).

Site-specific data indicates a low usage of the proposed development area and low numbers of transits across the site consequently a low risk of collision.

Based on the very small numbers of Sandwich terns recorded within the proposed development area and the relatively high avoidance rates reported for Sandwich terns at other wind farms, it is predicted that approximately one Sandwich tern may collide every three to five years and therefore the risk of collision is low, temporally long-term and of negligible magnitude and minor significance.

Barrier effect

Studies undertaken in UK and Belgium have shown that there is unlikely to be a barrier effect with Sandwich terns recorded foraging within operating wind farms and no strong avoidance behaviour (e.g. Everaert and Stienen 2006). Furthermore, boat-based data indicates that the majority of Sandwich terns in Aberdeen Bay forage predominantly within

2 km of the coast. The potential magnitude and significance of any impact, should it occur, will be negligible.

Displacement

Evidence from studies undertaken in Belgium and the UK has not shown any evidence of a displacement effect on Sandwich terns with birds entering operating wind farms (Everaert and Stienen 2006; Zucco *et al.* 2006). Therefore, it is predicted that any potential impact from displacement arising from the physical presence of the proposed development will be temporally long-term and of negligible magnitude and significance.

Disturbance

As with little terns, Sandwich terns are predicted not to be significantly impacted directly by disturbance from construction or operating vessels. However, they could, in theory, be impacted indirectly if the construction of the proposed project has an impact on the availability of their prey. However, unlike with little terns this potential impact has not been reported from any offshore wind farm.

Sandwich terns feed predominantly on sandeels and clupeids (young herring) and should they be impacted by construction activities in the vicinity of the proposed development then Sandwich terns may have to either forage more widely or find alternative prey. It is not possible to determine whether either of the possible impacts are potentially likely but Sandwich terns do forage widely in the coastal waters of Aberdeen Bay and based on two years of boat-based survey data appear not to frequently occur in the proposed EOWDC area so those that are effected may be able to relocate should there be a localised effect.

Monitoring at existing offshore wind farms have not reported any decreases in fish species or biomass post-construction caused by the construction or operation of the wind farm (e.g. Lindeboom *et al.* 2011; Vattenfall 2009; DBERR 2007; Jensen *et al*. 2004). Consequently, it is predicted that should piling occur, any potential impacts on fish would be of a relatively short duration and of minor significance (See Marine Ecology Appendices 9.1 and 9.2 of ES). However, there is the potential for a temporally short-term effect of low magnitude on Sandwich terns should the construction of the proposed development cause a significant decline in the prey of Sandwich terns during the breeding season. If this effect occurs, it is predicted, based on existing monitoring results that it would last no longer than a single season, before fish numbers returned back to population levels expected prior to construction. The impact will be of minor significance.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts.

There is the potential for a cumulative impact on Sandwich terns from the two turbine onshore Keith Inch and Green Hill development at Peterhead to the north of the proposed development (SNH 2011a). There are no data available on the number of Sandwich terns recorded at the Keith Inch and Green Hill development (Green Cat Renewables 2011) and therefore cumulative collision risk modelling is not possible. The number of Sandwich terns breeding to the north of Peterhead, at the Loch of Strathbeg, is very low with usually none or occasionally one or two pairs having bred there in recent years. Therefore, the number of Sandwich terns occurring in Aberdeen Bay associated with this SPA is predicted to be low. Sandwich terns forage offshore and although capable of flying overland to and from feeding areas, the Loch of Strathbeg is approximately 54 km away from the proposed EOWDC and beyond the mean maximum foraging range for this species of 49 km and the mean foraging range of 11 km (Thaxter *et al*. 2012). It is therefore predicted that few, if any, Sandwich terns from the Loch of Strathbeg will occur in the proposed development area.

Outwith Aberdeen Bay there are further planned wind farms in the Moray Firth and Firth of Forth areas.

Surveys undertaken at the Beatrice Demonstrator Project and the proposed Beatrice offshore wind farm located in the Moray Firth did not record any Sandwich terns and there are no Sandwich tern colonies in the Moray Firth area. Therefore, Sandwich terns are unlikely to occur regularly in the Moray Firth. Sandwich tern is a qualifying species for its post-breeding passage population in the Firth of Forth SPA and as breeding species in the Forth Islands SPA. The SPA citation for the Forth Islands states 22 pairs of Sandwich tern but no pairs have nested there in recent years.

The detailed distribution of Sandwich terns in the Firth of Forth is unknown and there are no site-specific data available to indicate whether Sandwich terns occur in the vicinity of the planned offshore wind farms. However, published seabirds at sea data indicate low densities occurring in the Firth of Forth area during the summer months with no records offshore during September or October (Stone *et al.* 1995). The Firth of Forth SPA is also approximately 124 km away from the proposed development and therefore the risk of any cumulative or in-combination impacts are low. Any impacts, should they occur, will be temporally long-term, of negligible magnitude and of minor significance.

Table 4-65: Summary of significance of potential impacts on Sandwich tern.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	High	Low	Medium	Minor
Operation	Collision	Very High	Negligible	Long-term	Minor
	Displacement	High	Negligible	Long-term	Negligible
	Barrier	Medium	Negligible	Long-term	Negligible
Decommissioning	Displacement	High	Negligible	Medium	Negligible
Cumulative	All	Very High	Negligible	Long-term	Minor

4.31.5 Conclusions

Habitats Appraisal

Based on the evidence from existing offshore wind farms indicating both a very low collision risk, little or no displacement and that there are not expected to be any barrier effects; there will not be any adverse effects on the SPA for which Sandwich tern is a qualifying species. However, should there be an impact on the prey items of Sandwich terns during the construction period then there is the potential for a short-term adverse effect for a single season but after which no adverse effects are predicted.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there may be a minor impact arising from the proposed development on Sandwich tern. In particular, during the construction period where there may be some displacement effects due to impacts arising from the potential reduction in the availability of suitable prey species during the breeding season although the effect is not thought to be significant.

4.32 Common tern (*Sterna hirundo*)

4.32.1 Protection and Conservation Status

The common tern is listed in Annex I of the Birds Directive, Appendix II of the Bonn Convention, Appendix II of the Bern Convention and is on the Green List of Species of Conservation Concern.

4.32.2 Background

Common tern		
GB population	10,000 prs.	BTO 2011
Scottish population	4,800 AoN.	Forrester *et al.* 2007
International threshold	1,900 ind.	Calbrade *et al*. 2010
GB threshold	200 ind.	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	Ythan Estuary, Sands of Forvie and Meikle Loch – 4 prs (2010). Forth Islands 378 prs.	SNH 2011b JNCC 2011a
European population estimate	Breeding 270 – 570,000 prs. Wintering – unknown	Birdlife 2004
European population trend	Status 'secure' Trend 'stable'	Birdlife 2004
World population	1.6 – 4,600,000 ind.	Birdlife 2011

Common terns are a widespread summer visitor to the UK, arriving from their wintering grounds off West Africa during April and May and departing in August and September (Snow and Perrins 1998). They nest colonially along coasts and inland along rivers and freshwater bodies. Coastal breeders feed predominantly on small fish, which are caught by plunge diving at heights of between 3 to 8 metres in nearshore waters, shallow bays and lagoons (Kirkham and Nisbet 1987). They have however been reported to forage up to 34 km from their breeding sites (BirdLife International 2012) with a mean maximum foraging range of 15.2 km and a mean foraging range of 4.5 km (Thaxter *et al*. 2012).

There are approximately 10,000 pairs of common tern in Britain of which approximately 4,800 nest in Scotland (Forrester *et al*. 2007). In North-east Scotland common terns are found along all the region's coasts with the largest coastal breeding colonies at the Sands of Forvie, St Fergus Gas Terminal and Loch of Strathbeg (Busuttil 2011a). They also breed inland of Aberdeen and birds from these colonies may forage offshore. Numbers of breeding common terns have until recent years increased at the Loch of Strathbeg compared to the Sands of Forvie where only a few pairs now breed (Figure 4-67). Terns are known to relocate from one colony to another across years due to various factors including disturbance, habitat loss, food shortages or predation (Ratcliffe *et al*. 2000). Therefore the common terns now breeding at St Fergus Gas Terminal may originate from the Sands of Forvie. Peak numbers arrive during May and the birds remain in the region until August and September. The latest population estimates for North-east Scotland are between 200 and 400 pairs (Busuttil 2011a).

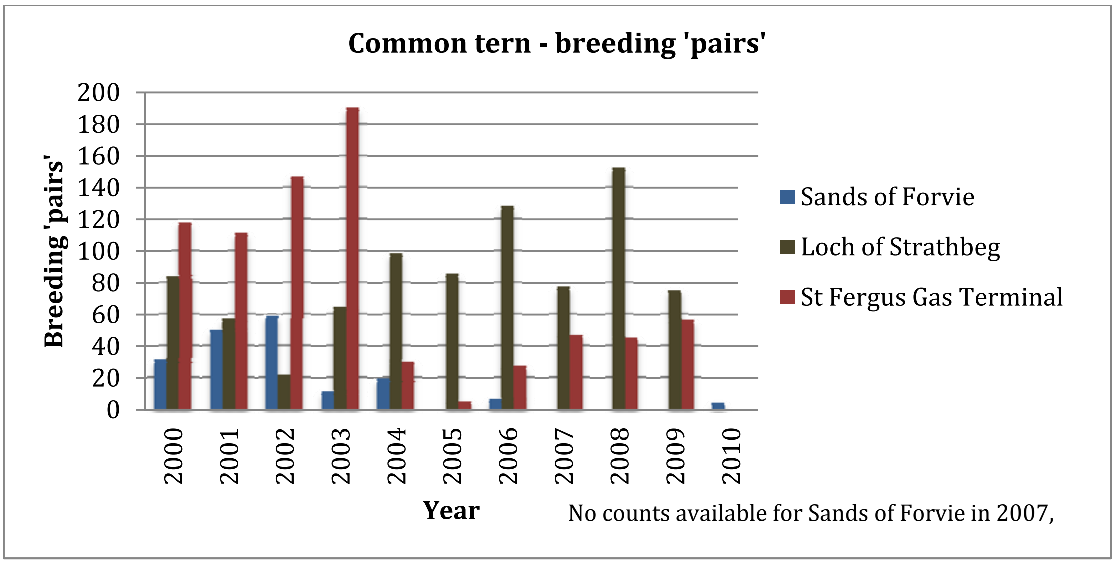


Figure 4-67: Numbers of breeding common tern at three main colonies in North-east Scotland (Source JNCC 2011a).

The identification of common and Arctic tern is difficult at any range and consequently records of distant passing birds are not assigned to either species and are recorded as 'commic' terns.

Passage of 'commic' terns past Peterhead occurs from April to September with peak numbers of up to 40 birds per month during July. Most records were of birds within several hundred metres from the shore (Innes 1994).

Boat-based survey

Common terns were recorded from boat-based surveys between April and September with peak encounter rates during May and July. Peak counts in May of 30 common terns recorded in the whole survey area and 125 in July are greater than the breeding population at the Sands of Forvie and are therefore likely to be of birds from either the Loch of Strathbeg and St Fergus colonies or more likely passage birds from elsewhere. Counts in July may also include locally bred juvenile birds. In Year 1 there were no confirmed sightings of common tern within the proposed development area although two birds were recorded as either being common or Arctic tern. In Year 2 a total of three common terns and five 'commic' terns were recorded within the proposed EOWDC area from the five boat-based surveys undertaken between April 2011 and July 2011 and six common terns from surveys undertaken between August and March. The majority of sightings were to the north, near the Ythan Estuary (Appendix B).

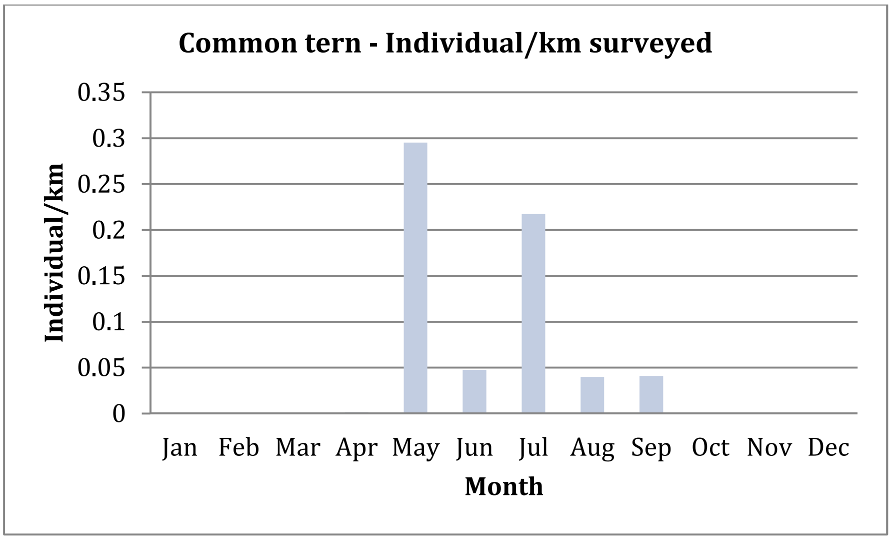


Figure 4-68: Encounter rates of common terns/km surveyed in Aberdeen Bay from two years of survey data.

Vantage Point surveys

In Aberdeen Bay common terns were recorded from April through to September with peak counts varying across years. In 2006 peak counts occurred during July and August when up to 50 birds per hour were recorded compared to a peak of less than 10 birds per hour in August 2005 and five birds per hour during the same period in 2007 (EnviroCentre 2007, Alba Ecology 2008a). In 2008, the peak counts occurred in May when up to ten birds per hour passed the Donmouth. Relatively low numbers were recorded during June when birds were breeding.

The majority of sightings were of birds between 0 - 2 km from the coast and at least 83% of sightings were of birds flying below 30 m.

Bird Detection Radar

There were no common terns observed during the radar surveys undertaken at Drums and Easter Hatton during October 2005. In April 2007 a total of 14 common terns were recorded from Blackdog at a rate of 0.27 birds per hour (Simms *et al*. 2007).

4.32.3 Summary of Results

Numbers of common terns from boat-based surveys peaked during May and July. Although land-based observations indicate that the timing of peak counts varied between years with some occurring in May and others in July and August when up to 50 birds per hour were recorded. At least 83% of sightings from land-based surveys were of birds flying below 30 m.

4.32.4 Species Sensitivities

Qualifying species

The common tern is a qualifying species for the Ythan Estuary, Sands of Forvie and Meikle Loch SPA where six pairs nested in 2009 and four pairs in 2010 and the Forth Islands SPA where 378 pairs nest.

Flight height

Out of 137 recorded flight heights for common tern obtained from site-specific boat-based surveys 97% were of birds flying below 25 metres and only three birds were recorded flying above 25 m.

Elsewhere, based on 19,332 recorded flight heights of common tern, modelling predicts 8% as being at rotor height (Cook *et al*. 2012).

Collision risk

Results from site specific surveys using boat-based and land-based surveys and other data sources (e.g. NESBR) indicate that common terns may occur within the proposed development area but in lower numbers than areas to the north. Only one specifically identified common tern was recorded from boat-based surveys within the proposed development area in year 1 and up to 3 during the breeding season in Year 2.

Three common terns were recorded as flying at rotor height from boat-based surveys (Table 3-6).

Site specific survey results and other data sources indicate that common terns occur widely to the north of the proposed development area and are relatively scarce within the proposed development area.

In order to determine potential effects of collision on common tern a collision risk assessment has been undertaken (Appendix A1).

The CRM predicts between 0 and 2 common terns may collide with the proposed development depending on the avoidance rate selected and use of site specific or generic modelled data (Table 4-66).

Table 4-66: Common tern predicted collision mortalities per year.

Rochdale	Flight height data source	Avoidance rate (%)			
		95.0	98.0	99.0	99.5
Original	EOWDC	1 +/- 1.14	0 +/- 0.45	0 +/- 0.23	0 +/- 0.11
	Generic	2 +/- 3.39	1 +/- 1.36	0 +/- 0.68	0 +/- 0.34
Revised	EOWDC	0 +/- 0.76	0 +/- 0.30	0 +/- 0.15	0 +/- 0.08
	Generic	1 +/- 2.27	1 +/- 0.91	0 +/- 0.45	0 +/- 0.23

Based on the precautionary avoidance rate of 98% it is predicted that no more than one collision per year may occur.

The annual mortality rate for common tern is 10% (BTO 2011). Based on the regional SPA population of 768 breeding adults, the annual mortality rate will be 153 individuals and therefore the 1% baseline mortality rate is less than two birds per year. The results from the collision risk modelling predict one or less collisions per year.

Between zero and six pairs of common tern have nested on the Ythan Estuary in recent years and the population is not in favourable condition (Figure 4-67) and consequently an increase in adult mortality could have an adverse effect. The Ythan Estuary lies approximately 7.2 km away from the proposed development and therefore may be within the potential foraging range of breeding common terns, which have a reported estimated mean maximum foraging range of 15 km and a mean foraging range of 4.5 km (Thaxter *et al*. 2012).

A total of 378 pairs of common tern nest at the Firth of Forth, which lies approximately 124 km away and therefore outwith the maximum foraging range recorded for common terns.

Data obtained from Zeebrugge, where common terns frequently pass across an array of turbines, have reported relatively high collision mortalities although very low collision probabilities of 0.1% for birds flying at rotor height and 0.007% for birds at all altitudes (Everaert and Stienen 2006). Consequently, the use of a 98% avoidance rate is precautionary and it is predicted that avoidance of 99% or greater is likely.

Based on these results the number of potential collisions of common terns may be between zero and one bird per year.

The numbers of common terns recorded during surveys were greater than the number of breeding pairs at the nearest SPA. Consequently, not all the common terns recorded were from the SPA. There are two other common tern colonies in the region: Loch of Strathbeg and St Fergus (Figure 4-67).

The Loch of Strathbeg lies approximately 47.6 km away and St Fergus *c.* 39 km and therefore both colonies are outwith the maximum foraging ranges of these birds during the breeding season. However, SNH have advised that birds occurring at St Fergus are likely those originating from the Ythan Estuary, Sands of Forvie and Meikle Loch SPA and that hypothetical collision risk modelling should be undertaken to determine whether the population of common terns at this SPA could be maintained should it return to the population level at citation, i.e. 256 pairs (SNH 2011a).

Collision risk modelling undertaken based on the hypothetical higher densities indicate that between 12 and 122 common terns per year may collide with the proposed development should the population increase to 250 pairs (500 individuals) and depending on the avoidance rate (Appendix A2, Table 4-67).

Table 4-67: Predicted number of common tern collisions with increasing colony size.

Common tern Population	No. of transits through rotors	Collisions assuming no avoidance	Avoidance rates (%)			
			95	98	99	99.5
10	455	33	2	1	0	0
50	3,410	246	12	5	2	1
100	6,821	491	25	10	5	2
500	33,876	2,440	122	49	24	12
1,000	67,865	4,888	244	98	49	24

Based on avoidance rate of 98% then an estimated 49 common terns per year may be at risk of collision and at 99%, 24 birds per year.

The wind farm at Zeebrugge comprises of a line of 25 small to medium turbines along a sea wall with hub heights varying from between 23 m and 53 m, rotor diameters up to 53 m and rotor heights of between 16 m and 50 m. Beside the turbines there is a mixed breeding colony of terns including up to 1,832 common terns. Terns flying to and from their colony cross the line of turbines (Everaert and Stienen 2006). Studies undertaken on collision mortality have reported avoidance rates by common terns higher than 99% and the risk of a collision with one of the turbines of 1 in 848 for all common terns flying at rotor height and 1 in 13,387 for common terns flying at all heights (Everaert and Stienen 2006; Everaert & Kuijken 2007).

The frequency of passages recorded at Zeebrugge are significantly greater than are predicted to occur at the proposed EOWDC with a mean number of daily flights at Zeebrugge of between 4,228 and 10,263 of which between 7% and 27% were at rotor height. The turbines at Zeebrugge are also significantly closer together, being spaced approximately 100 to 150 m apart compared to over 600 m at EOWDC. Consequently, the likelihood of a collision occurring at Zeebrugge is likely to be higher than that at the proposed EOWDC where the frequency of flights through the site are significantly lower and the turbines are spaced further apart and only 2.7% of flights are at rotor height.

Site specific data indicates that the majority of Terns forage within the nearshore waters to the north of the proposed development (Appendix B) and rarely occur further offshore. Data from other colonies in Norfolk also indicates that during the breeding season common terns forage mainly within 2 km of the coast and rarely go further, but can do so and this may vary across colonies and across months (Allcorn *et al*. 2003).

The modelling assumes that the density of birds within the proposed EOWDC area is the same as that to the north and near the Ythan Estuary. However, site specific data indicates that this is not the case with no more than a total of three specifically identified common terns recorded in the area of the proposed wind farm during a single breeding season with the majority to sightings to the north nearer to the breeding colony (Appendix B). Thus suggesting a very low utilisation of the area by common terns breeding within the SPA and that the modelling is unrealistic in its assumptions and overly precautionary. The densities within the proposed development area are likely to be significantly lower than nearshore and near the Ythan Estuary than those used in the collision risk modelling.

It is not possible to calculate what the actual densities of common tern might be should the population of common terns increase to 250 pairs at the Sands of Forvie. However, the densities within the proposed development area are likely to be significantly lower than nearshore and near the Ythan Estuary than those used in the collision risk modelling. This is supported by the very low densities recorded for other, more abundant, species of tern also nesting in the Sands of Forvie, in particular the Arctic tern and Sandwich tern. Collision risk modelling was not possible for Arctic tern due to the very low numbers recorded and their low flight height even though nearly 400 pairs nested there in 2010. The breeding population of Sandwich terns was up to 670 pairs during the years when surveys were undertaken and the collision risk modelling indicates less than one collision per year for this species. Although not directly comparable, the very low numbers of other, more abundant, species of tern nesting in the same colony predicted to be at risk of collision indicates that similar levels of impact may be predicted should the population of common terns increase to 250 pairs.

Based on the site specific data and known distribution and flight heights of common terns present in Aberdeen Bay and evidence from existing wind farms indicating high avoidance rates it is predicted that the potential collision risk is significantly lower than modelled and likely to be temporally long-term of negligible magnitude and minor significance but will not cause a significant impact on common terns.

Barrier effect

Studies undertaken in UK, Belgium, Denmark and Sweden have shown that there is unlikely to be a barrier effect, with common (or common/Arctic) terns recorded foraging within operating wind farms and no reports of any strong avoidance behaviour (Petersen *et al.* 2006; Pettersson 2005; Zucco *et al.* 2006). However, post-construction monitoring undertaken at Kentish Flats have shown a potential barrier effect with fewer common terns flying through the operating wind farm than compared to prior construction (Gill *et al*. 2008). The location of the proposed development to the south of the tern colony on the Sands of Forvie and that site specific monitoring indicates that areas to the north of the proposed development are preferred indicates that there are unlikely to be any potential impacts. Any possible impacts will be temporally long-term and of negligible magnitude and of minor significance. No significant or adverse effects to common terns will occur due to potential barrier effect.

Displacement

Monitoring studies undertaken in Denmark reported common terns entering operating wind farms indicating that there may be little or no displacement (Petersen *et al.* 2006). Common terns were not recorded regularly using the proposed development area but should displacement occur, site specific data indicates that they may forage elsewhere, particularly to the north, which based on the numbers of common terns present, is a preferred foraging area. Any possible impacts will be temporally long term and of negligible magnitude and significance.

Disturbance

Common terns may not be impacted directly by activities associated with the proposed development, i.e. vessel movements, but there is the potential for a secondary impact should the prey of common terns be affected by construction activities, particularly pile driving. Common terns forage on small fish, young clupeids, and crustaceans (shrimps). Should the construction of the proposed development cause a reduction in the availability of prey to breeding terns then this could cause an adverse effect.

Monitoring results at existing offshore wind farms have indicated that there are not decreases in fish species or biomass following construction of offshore wind farms (e.g. Lindeboom, *et al.* 2011; Vattenfall 2009; DBERR 2007; Jensen *et al*. 2004). Consequently, it is predicted that any potential impacts on fish, should they occur arising from piling activities would be of a relatively short duration and of minor or moderate significance (See Marine Ecology Appendices 9.1 and 9.2 of ES).

The location of nearest tern colonies 7 km away and that more common terns were recorded to the north of the development area indicate that should there be a reduction of suitable prey in the vicinity of the proposed development from pile driving, then there are other areas where common terns may forage, e.g. in the Ythan Estuary. Any potential impact will likely last for no more than the one season during construction as fish will be available as prey following cessation of construction.

The significance of any potential effect depends on the type of installation technique used the subsequent scale of disturbance and its duration. It also depends on whether other suitable foraging areas are available. Although these are difficult to predict any potential impacts upon prey are expected to be relatively short-term as they may only effect one or possibly two breeding seasons, as new fish will become available for the season following construction. Post construction monitoring undertaken at Kentish Flats did not record any reduction in the number of terns using the area and noted an increase in overall numbers indicating no significant effect from construction on Terns (Gill *et al*. 2008).

Based on the results from site specific surveys and evidence from studies undertaken at other constructed wind farms it is predicted that any potential displacement impact arising from construction may be of short to medium term, low magnitude and of minor significance.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts.

Outwith Aberdeen Bay there are further planned wind farms in the Moray Firth and Firth of Forth areas.

Collision risk modelling undertaken for all species of tern recorded at the Beatrice Demonstrator Project located in the Moray Firth predicted an annual mortality rate of less than 1 bird per year. Only one common tern was recorded during two years of surveys undertaken for the proposed Beatrice offshore wind farm (BOWL 2012). The predicted additional mortality rate is therefore low and of minor significance.

The detailed distribution of common terns in the Firth of Forth is unknown and there are no site specific data available to indicate whether common terns occur in the vicinity of the planned offshore wind farms. However, published seabirds at sea data indicate low or very densities occurring in the Firth of Forth area with no records in the area where wind farms may in the future be developed (Stone *et al.* 1995). The Firth of Forth SPA is approximately 124 km away from the proposed development and therefore no cumulative or in-combination impacts are predicted.

Table 4-68: Summary of significance of potential impacts on common tern.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	High	Low	Medium	Minor
Operation	Collision	Very High	Negligible	Long-term	Minor
	Displacement	High	Negligible	Long-term	Negligible
	Barrier	Very High	Negligible	Long-term	Minor
Decommissioning	Displacement	High	Negligible	Medium	Negligible
Cumulative	All	Very High	Negligible	Long-term	Minor

4.32.5 Conclusions

Habitats Appraisal

Based on the evidence from existing offshore wind farms indicating both a low collision risk, little or no displacement or barrier effects; there will not be any adverse effects on the SPA for which common tern is a qualifying species. However, should there be an impact on the prey species for common tern during the construction period then there is the potential for a localised impact.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there may be a minor impact arising from the proposed development on common tern if the construction of the proposed development causes a displacement of fish species. The impact will be of short duration, predicted to be no more than one breeding season, and no significant effect will occur.

4.33 Arctic tern (*Sterna paradisaea*)

4.33.1 Protection and Conservation Status

The Arctic tern is listed in Annex I of the Birds Directive, Appendix II of the Bonn Convention, Appendix II of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.33.2 Background

Arctic tern		
GB Population	52,600 prs.	BTO 2011
Scottish population	47,300	Forrester *et al*. 2007
International threshold	Unknown	Calbrade *et al*. 2010
GB threshold	1,000 ind.	1% of UK breeding pop[n]
Designated east coast sites where species is a noted feature	Forth Islands: 908 prs.	SNH 2011b JNCC 2011a
European population estimate	Breeding 500,000 – 900,000 prs. Wintering – none	Birdlife 2004
European population trend	Status 'secure' Trend 'unknown'	Birdlife 2004
World population	2,000,000 mature ind.	Birdlife 2011

Arctic terns are a summer migrant to northern Europe and winter in the Antarctic. They arrive on their breeding grounds during April and May and depart during August and September. They breed in colonies on undisturbed beaches and islands and numbers in colonies varies considerably across years with birds regularly switching colonies. They forage in mainly coastal waters feeding predominantly on small fish by plunge diving to just below the surface.

In North-east Scotland Arctic terns occur from April through to September with a breeding population of between 300 and 650 pairs at four main colonies (Figure 4-69) (Busuttil 2011b).

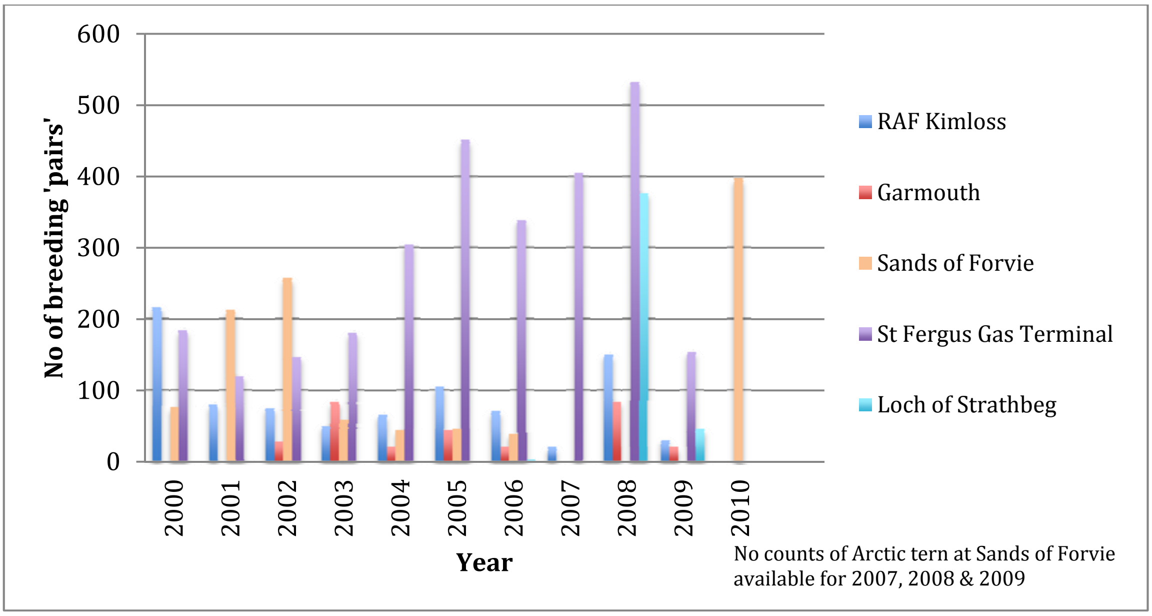


Figure 4-69: Arctic tern breeding 'pairs' in North-east Scotland.

During passage an estimated 200,000 Arctic terns may occur in Scotland with peak numbers in July when up to 40 birds per month were recorded past Peterhead (Forrester *et al.* 2007; Innes 1994).

Boat-based surveys

In Year 1 surveys only three Arctic terns were recorded all in July 2007 (IECS 2008). During Year 2 surveys, Arctic terns were more frequently recorded with peak numbers during the post-breeding season in July and August. Up to ten Arctic terns were recorded during the five surveys undertaken between April 2011 and July 2011 within the proposed development area and a further six 'commic' terns may have been this species. Outwith the breeding season up to 11 Arctic terns were recorded between August and March 2011.

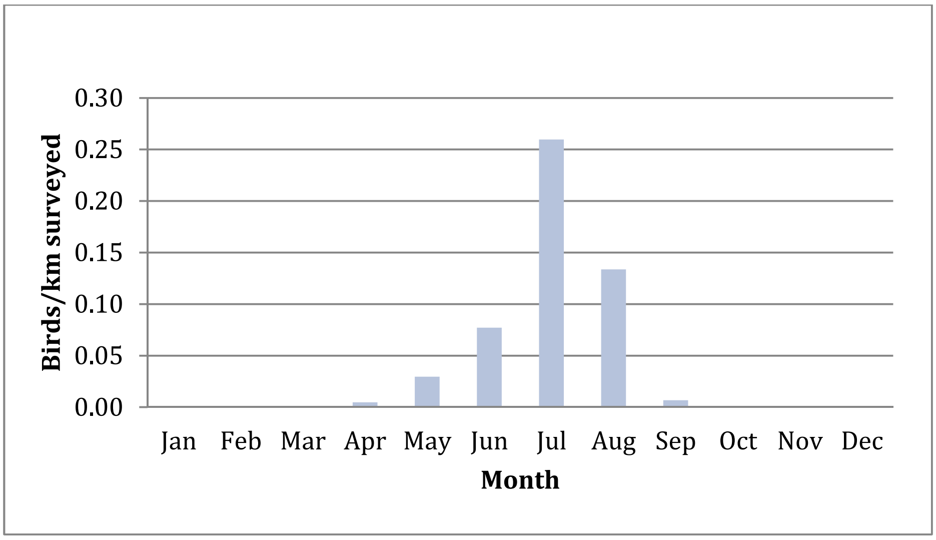


Figure 4-70: Arctic tern encounter rates based on two years of boat-based surveys.

During the breeding season the majority of Arctic tern sightings were recorded to the north of the proposed development area near to the Ythan Estuary and north of Collieston. Outwith the breeding season Arctic terns were more widespread with records further offshore potentially being passage birds (Appendix B).

Vantage Point surveys

Arctic terns were regularly recorded in Aberdeen Bay from April through to October with a distinct peak in numbers between June and August. Peak numbers varied considerably across years with up to 150 birds per hour passing Drums in July 2008 but a peak of only up to ten birds per hour in June 2007 (EnviroCentre 2007; Alba Ecology 2008a). Birds were recorded less than 2 km from shore and up to 36% of sightings were greater than 30 m above sea surface.

Bird Detection Radar

There were no Arctic terns recorded during the radar surveys undertaken at Drums and Easter Hatton during October 2005. In April 2007, two Arctic terns were recorded from Blackdog (Simms *et al*. 2007).

A further 23 common/Arctic terns were recorded during the April 2007 radar surveys (Simms *et al*. 2007). All terns recorded from the radar surveys were seen flying below 30 m.

4.33.3 Summary of Results

Numbers of Arctic terns recorded from boat-based surveys in Year 1 was very low but they were regularly recorded during Year 2 surveys and from land-based counts between April through to October with peak counts during July. Numbers recorded from land based observations varied but were generally less than 10 birds per hour with one exceptional count of 150 birds per hour in July 2008. The majority of sightings were within 2 km of the coast and 36% of all sightings from land were of birds flying above 30 m.

There is no UK threshold but the peak count of 150 birds per hour in July 2008 was less than the 1% of the national breeding population.

4.33.4 Species Sensitivities

Qualifying species

The Arctic tern is a qualifying species for the Forth Islands SPA where 908 pairs nest.

Flight height

Out of 125 Arctic terns for which flight heights were recorded, none were observed as flying at heights greater than 25 m. Out of a further the 29 flights for ‘commic’ (common/Arctic) terns none were above 25 m.

Elsewhere, Arctic terns flight heights of 2,571 Arctic terns have been reported from other offshore wind farm surveys and modelling predicts 4 % of flights at rotor height (Cook *et al.* 2012).

Collision risk

Only three Arctic terns were recorded from site specific boat-based surveys in Year 1 but 366 were recorded in Year 2. No Arctic terns were recorded flying at turbine height and the majority of sightings were of birds within 2 km of the coast and to the north of the proposed development area (Appendix B), indicating that there is a low risk of collision within the proposed development.

Collision risk modelling is not feasible due to the low number of sightings within boat-based survey ‘snapshots’. However, the lack of any Arctic terns recorded at rotor height and few records from within the proposed development area, indicates that the potential for an adverse or significant impact to occur is very low. The potential impacts are long-term but of negligible magnitude and minor significance.

Barrier effect

Studies undertaken in Denmark and Sweden (Petersen *et al.* 2006; Pettersson 2005) have indicated that there is unlikely to be a barrier effect with common/Arctic terns recorded foraging within operating wind farms and no strong avoidance behaviour. The majority of sightings were recorded to the north of the proposed development area and therefore the potential for a barrier effect, should it occur, during the breeding season is not predicted to be significant.

Peak numbers of Arctic tern recorded within Aberdeen Bay were during July and may be of passage birds from colonies to the north and the wintering grounds to the south. Arctic terns winter in the Antarctic and undertake an annual migration of approximately 40,000 km. Consequently, should the proposed development cause a barrier effect on migrating Arctic terns the increase in distance of 3.2 km will not be significant or cause an adverse effect. Any impacts, should they occur, will be negligible in magnitude and significance.

Displacement

Results from studies undertaken in Denmark where common/Arctic terns were seen to enter operating wind farms indicates that there may be little or no displacement. The use of the site by Arctic tern is very low and therefore it is predicted that there will be little or no displacement effect caused by the physical presence of the proposed development.

Disturbance

Arctic terns may not be impacted directly by activities associated with the proposed development, i.e. vessel movements, but there is the potential for a secondary impact should the prey of Arctic terns be affected by construction activities. Arctic terns are opportunistic feeders foraging on small fish and crustaceans. Should the construction of the proposed development cause a reduction in the availability of prey to Arctic terns then this could cause an adverse effect.

Monitoring at existing offshore wind farms has not found any evidence of decreases in fish species or biomass post-construction caused by the construction or operation of a wind farm (e.g. Lindeboom, *et al.* 2011; Vattenfall 2009; DBERR 2007; Jensen *et al*. 2004). Consequently, it is predicted that any potential impacts on fish, should they occur arising from piling activities would be of a relatively short duration. Furthermore, results from site specific boat-based surveys suggest that the proposed development area and the surrounds are not of particular importance for Arctic terns and that should their prey be displaced, they would be able to find alternative areas to forage. Any potential impact, should it occur, will likely last for no more than one or at worse two seasons as fish will be available as prey within the proposed development area the following year. Impacts on fish from construction piling are predicted to be of minor or moderate significance (See marine ecology appendices 9.1 and 9.2 of ES).

Based on the results from site specific surveys and evidence from studies undertaken at other constructed wind farms it is predicted that any potential impact on Arctic tern will be of minor significance.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts.

Outwith Aberdeen Bay there are further planned wind farms in the Moray Firth and Firth of Forth areas.

The proposed Beatrice offshore wind farm recorded 29 Arctic terns during two years of boat-based surveys (BOWL 2012).

The detailed distribution of Arctic terns in the Firth of Forth is unknown and there are no site specific data available to indicate whether Arctic terns occur in the vicinity of the planned offshore wind farms. However, published seabirds at sea data indicate low or very densities occurring in the Firth of Forth area with no records in the area where wind farms may in the future be developed (Stone *et al.* 1995). The Forth Islands SPA is also approximately 124 km away from the proposed development and therefore the risk of any cumulative or in-combination impacts are very low.

Table 4-69: Summary of significance of potential impacts on Arctic tern.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	High	Low	Medium	Minor
Operation	Collision	Very High	Negligible	Long-term	Minor
	Displacement	High	Negligible	Long-term	Not significant
	Barrier	Medium	Negligible	Long-term	Not significant
Decommissioning	Displacement	High	Negligible	Medium	Not significant
Cumulative	All	Very High	Negligible	Long-term	Minor

4.33.5 Conclusions

Habitats Appraisal

The only SPA in the region for which Arctic tern is listed as a qualifying species is the Forth Islands SPA, which is approximately 124 km to the south. The risk of an adverse effect on the qualifying species is therefore low and should there be one, the impact will be not significant.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental effect arising from the proposed development on Arctic tern. However, there may be a temporary minor impact if there is disturbance to prey during construction.

4.34 Common Guillemot (*Uria aalge*)

4.34.1 Protection and Conservation Status

The (common) guillemot is listed in Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.34.2 Background

Guillemot		
GB Population	Breeding: 1,300,000 ind.	BTO 2011
Scottish population	Breeding: 780,000 prs Winter: 750,000 ind.	Forrester *et al.* 2007
International threshold	Unknown	-
GB threshold	13,000 ind.	1 of GB Pop[n]
Designated east coast sites where species is a noted feature	Buchan Ness to Collieston Coast – 19,296 ind. (2007) Fowlsheugh 50,566 ind. (2009) Troup, Pennan and Lion's head – 16,325 ind. (2007) Forth Islands 16,000	SNH 2011b JNCC 2011a
European population estimate	Breeding 2,000,000-2,700,000 prs. Wintering – 4,300,000 ind.	Birdlife 2004
European population trend	Status 'secure' Trend 'large increase'	Birdlife 2004
World population	7,300,000 – 7,400,000	Mitchell *et al* 2004

The guillemot is one the most abundant seabirds in the northern hemisphere with a large population in the Atlantic and numbers in Britain and Ireland have increased substantially during the last 30 years. Guillemots breed at most locations around the coast of Britain and Ireland where there is suitable cliff nesting habitat. The species is extremely gregarious, colonial nesting is the norm and colonies can contain tens of thousands of individuals (Wernham *et al*. 2002).

Birds may start to return to the colonies from their offshore wintering areas as early as October although many do not return until the spring. During the breeding season birds remain in proximity of their colonies but may forage in excess of 100 km from their breeding sites (Thaxter *et al*. 2012). The chick leaves the colony with the male when about three weeks old and still flightless. The male accompanies the chick for a further six to eight weeks while it develops and the adult undergoes a complete moult during which time it has a period that it becomes flightless (Snow and Perrins 1998).

Guillemots feed on a variety of small pelagic shoaling fish, especially lesser sandeels, sprats and members of the family Gadidae, which they catch by underwater pursuit after diving from the surface (Snow and Perrins 1998).

There is an estimated 1,000,000 pairs of guillemots nesting in Britain, of which 75% are in Scotland, the majority in Shetland, Orkney, Caithness, Sutherland and Western Isles (Mitchell *et al*. 2004).

In North-east Scotland the guillemot occurs widely throughout the region and there are number of significant breeding colonies with a regional population of 150,000 individuals. The region therefore holds approximately 10% of the UK and Scottish breeding populations. The main colonies in North-east Scotland are at Fowlsheugh, Between Boddam and Collieston and at Troup Head (Paterson 2011a). Over the last ten years there has been a decline in the numbers of guillemots breeding within North-east Scotland with decreases of between 18.8% and 64.0% (Table 4-70) (JNCC 2011a).

Table 4-70: Breeding guillemot population at three main colonies in North-east Scotland.

Colony	Year	No. of Individuals	% Change
Fowlsheugh	1999	62,330	-18.8
	2009	50,556	
Boddam - Collieston	2001	29,389	-34.3
	2007	19,296	
Troup Head	2001	45,354	-64.0
	2007	16,325	

A passage of guillemots has been recorded passing off Peterhead with a northerly passage of birds in the spring when up to 24,000 birds per hour have been counted. A smaller passage of birds occurs in the autumn with up to 400 birds per hour passing.

The passage of birds recorded past Peterhead extended from a few hundred metres from the shore to over 3 km (Innes 1990).

Boat-based surveys

Guillemot was the most frequently recorded species from boat-based surveys between February 2007 and April 2008 and again between August 2010 and August 2011. Guillemots were recorded throughout the year and throughout the surveyed area with birds recorded in shallow nearshore waters and further offshore in deeper waters of 30 m or more.

During the winter period data showed guillemots to be distributed throughout out the surveyed area in relatively low densities compared to other times of year. During the breeding and post-breeding season the numbers of guillemot present was greater than during the winter period. Highest numbers were recorded offshore to the north-east of the proposed development area and also to the north (Appendix B).

Numbers of guillemot in the winter period were lower than during the summer months when numbers peaked in July. Estimated monthly numbers using *Distance* analysis indicate a population of up to 2,578 guillemots within the 'control' area during July and a further 1,511 individuals in the proposed EOWDC survey area. Densities of up to 51 birds/km^2 and 30 birds/km^2 were estimated during this period (Figure 4-71 and Figure 4-72).

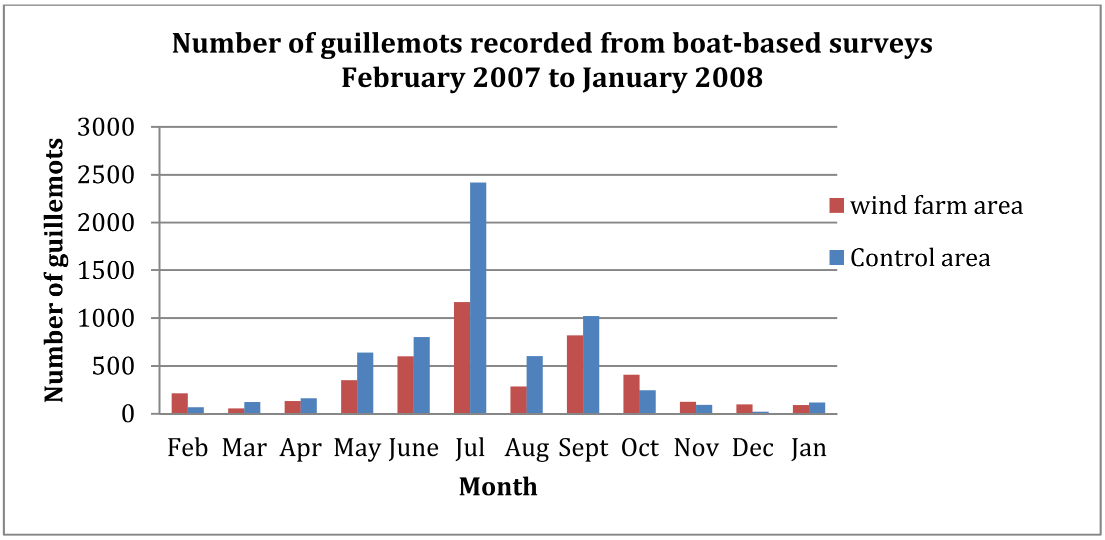


Figure 4-71: Guillemot monthly population estimates in proposed EOWDC and 'control' areas: Boat-based surveys 2007 – 2008.

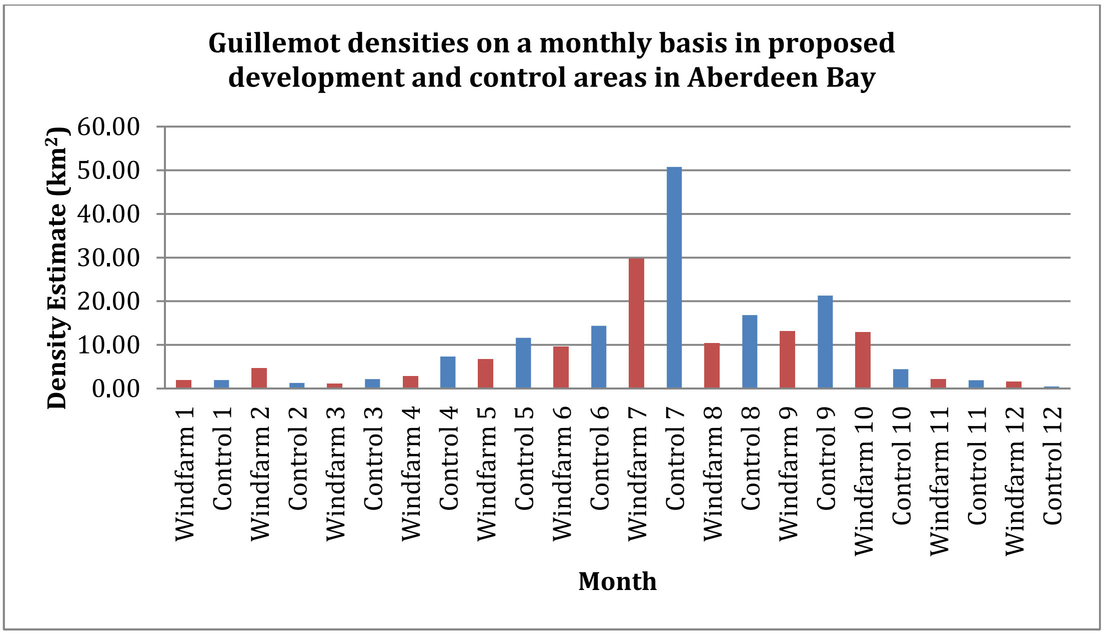


Figure 4-72: Monthly estimates of density of guillemots in the proposed EOWDC and 'control' areas; February 2007 – January 2008 ('Windfarm' 1-12 and 'control' 1-12 refers to months).

Data obtained between August 2010 and August 2011 indicated a relatively even distribution of guillemots across the whole survey area. Densities were lower during the winter period compared to the breeding and post-breeding seasons with numbers greatest to the north of the proposed development area. During the breeding period most sightings were to the north and offshore with relatively lower numbers within the proposed development area. Post-breeding numbers of guillemots observed increased and occurred widely across the whole surveyed area (Appendix B).

Density surface modelling undertaken on the Year 2 data indicate highest predicted densities of guillemot to the north of the proposed development area with predicted densities of up to 4.4 birds per km^2 to the north and 3.2 guillemots per km^2 within the proposed EOWDC during the breeding season (Figure 4-73 to Figure 4-76).

Distance modelling undertaken on Year 2 boat-based data recorded peak abundance in the North strata during June with an estimated 3,446 guillemots recorded and a total estimated population within the surveyed area of 5,313 individuals. Abundance during July 2011 was similar across the whole area but with a greater proportion of birds recorded in the southern strata. Abundance was generally lower offshore compared to the North and South survey areas. Lowest numbers of guillemot were recorded across all three strata during February and March 2011 (Figure 4-77).

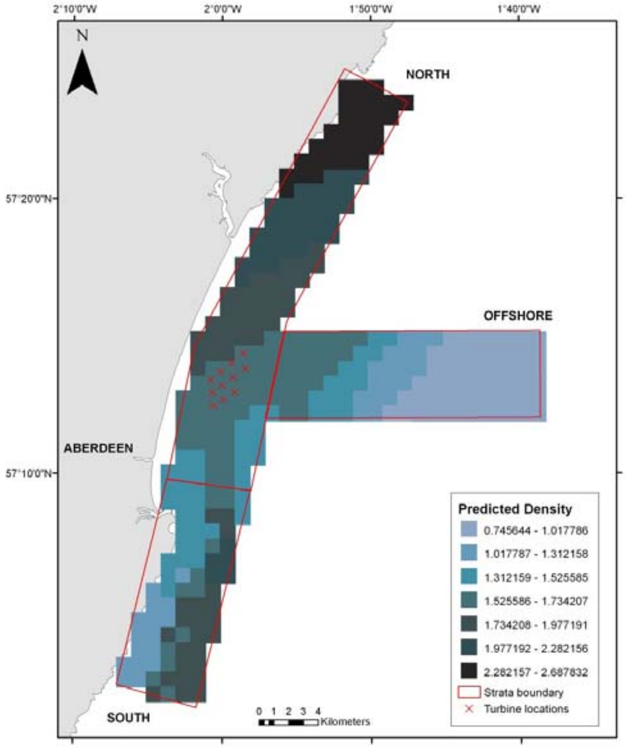


Figure 4-73: Density Surface Model results for guillemot during spring based on analysis of data from September 2010 to August 2011 (SMRU 2011c).

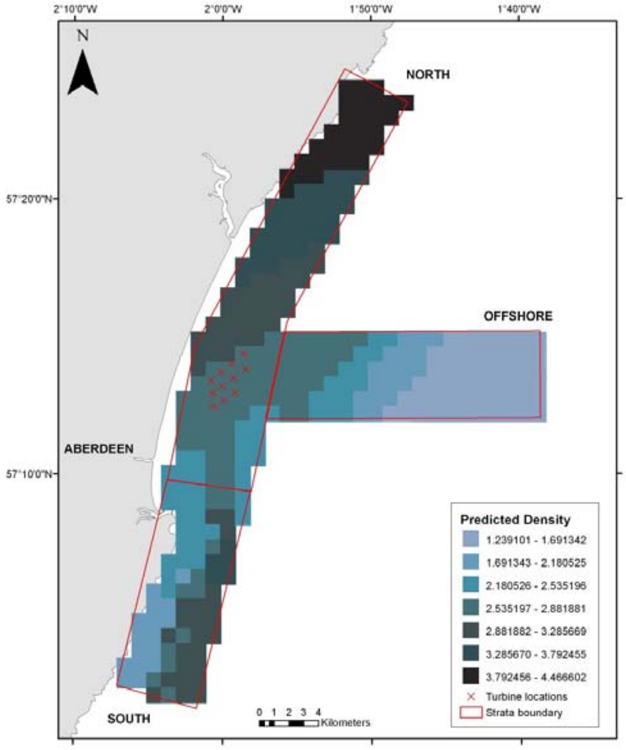


Figure 4-74: Density Surface Model results for guillemot during summer based on analysis of data from September 2010 to August 2011. (SMRU 2011c).

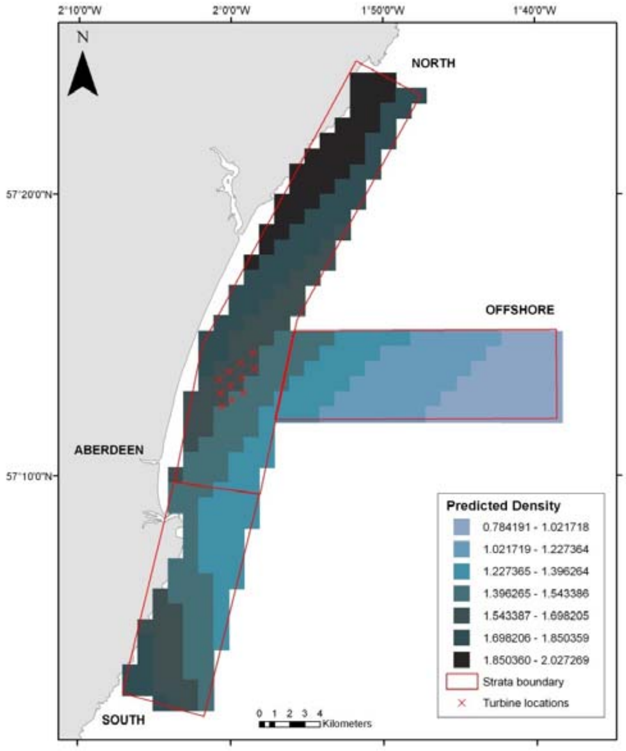


Figure 4-75: Density Surface Model results for guillemot during autumn based on analysis of data from September 2010 to August 2011 (SMRU 2011c).

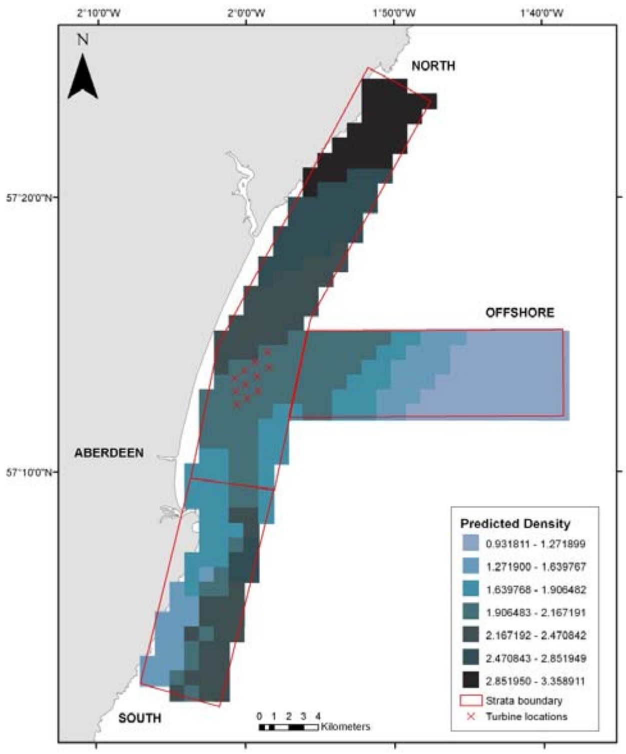


Figure 4-76: Density Surface Model results for guillemot during winter based on analysis of data from September 2010 to August 2011 (SMRU 2011c).

In contrast to abundance estimates, densities of guillemots peaked during July and August and were recorded in the offshore strata with a peak of 3.18 birds/km^2 in August. In the North strata, the area within which the proposed EOWDC may be developed, peak densities occurred in September 2010 at 1.24 birds/km^2 (SMRU 2011c).

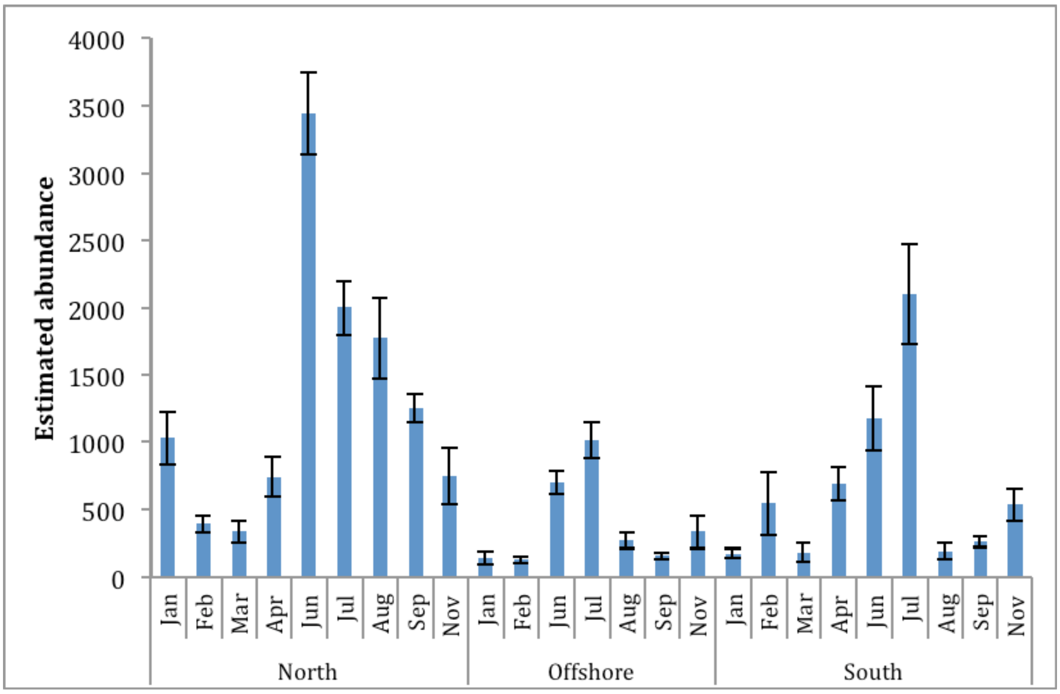


Figure 4-77: Monthly abundance estimates (+/- CV) of Common Guillemot in the South, North and Offshore Strata.

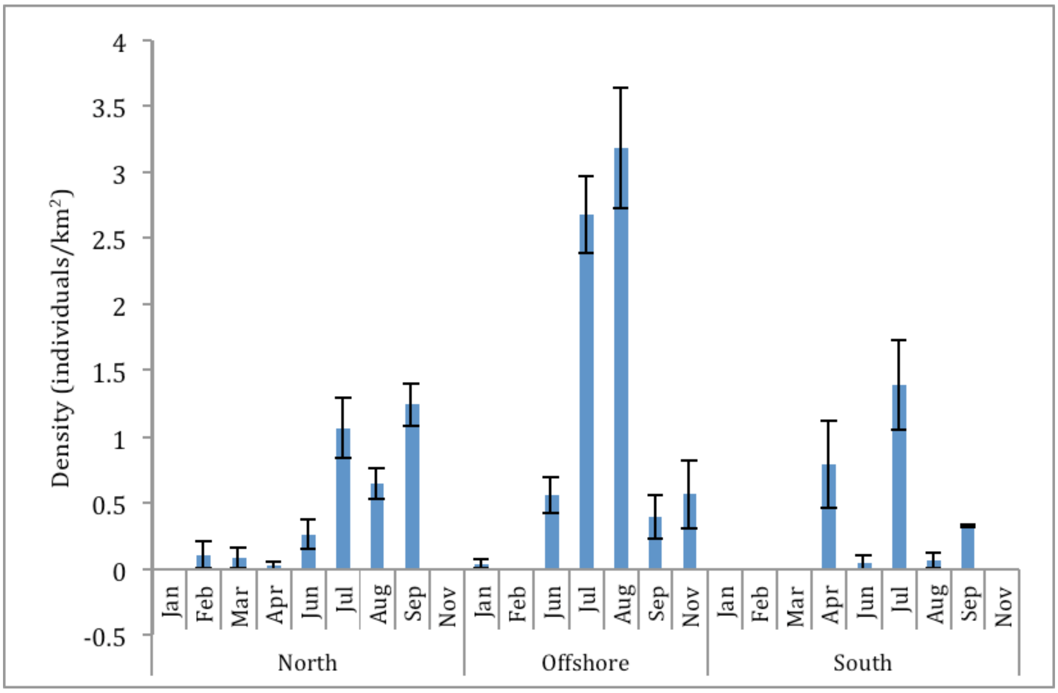


Figure 4-78: Monthly density estimates (+/- CV) for guillemot in the South, North and Offshore Strata between August 2010 and January 2011.

Year 1 and Year 2 Combined

Due to the numbers of guillemots recorded and the ability to undertake Distance modelling and Density Surface Modelling on the data collected from Year 1 and Year 2 surveys, it is possible compare densities on a seasonal basis across years (SMRU 2011c). The results indicate the densities of guillemots recorded in Year 2 in Aberdeen Bay were significantly lower during the breeding season compared to those recorded in Year 1. There were no significant differences during the winter period.

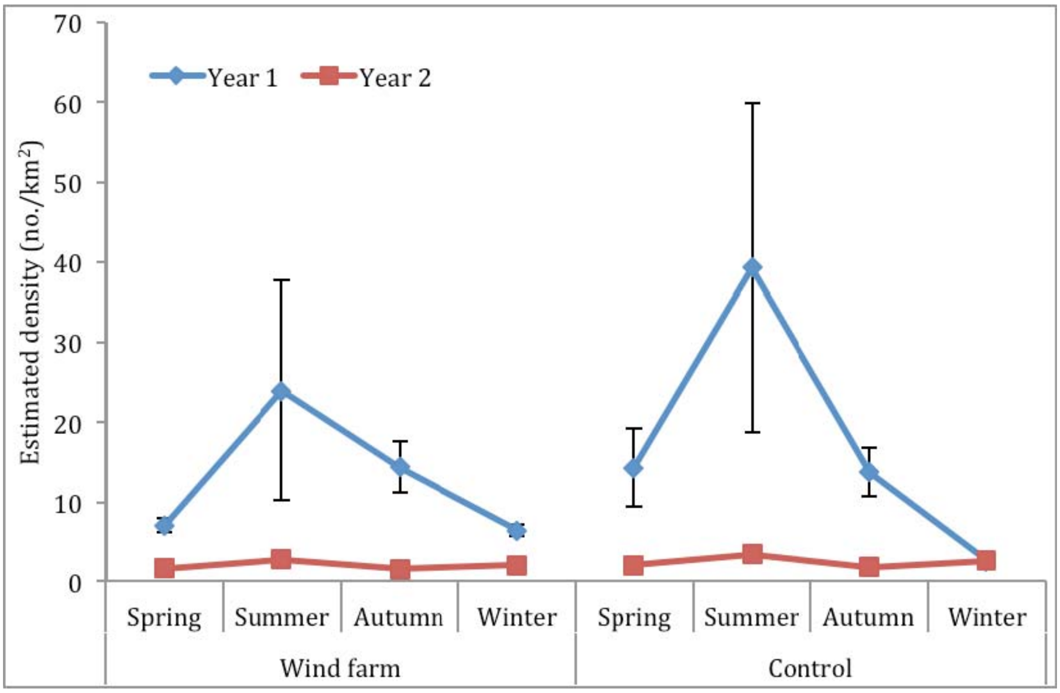


Figure 4-79: Estimated density of guillemots ± variance for two study areas used in Year 1 surveys, and in each season. Year 1 data are density estimates obtained from Distance sampling, where-as Year 2 data are extracted from Density Surface Models (SMRU 2011c).

Vantage Point surveys

Guillemots were present in Aberdeen Bay throughout the year. Relatively low numbers were present between December and February with numbers increasing from March onwards. Up to 250 birds per hour were recorded flying past in March 2007, increasing to up to 400 birds per hour during April 2007 (EnviroCentre 2007). At least 98% of all flights were below 30 m. Relatively few birds were recorded within 1 km of the coast with most between 1 km and 3 km (Alba Ecology 2008a,b).

Bird Detection Radar

A total of 259 guillemots were recorded during the radar studies undertaken in October 2005. The numbers recorded between the two survey sites were broadly similar with 108 at Drums and 151 at Easter Hatton. The distribution of guillemots was different between the two sites, with a larger proportion of birds at Easter Hatton recorded within 2.5 km from shore compared to Drums where a greater proportion were recorded out to 4.5 km. Combining observations from both sites suggests a generally broad distribution of guillemots (Walls *et al.* 2006).

4.34.3 Summary of Results

Guillemots were recorded widely across Aberdeen Bay from all surveys. Data from boat-based surveys indicate peak counts in the bay occur during the post-breeding period with highest densities recorded offshore during this period. Within the proposed EOWDC densities were greatest during September. Relatively high numbers remain within the area until November after which numbers of guillemots in the area decrease. Land based observations recorded peak numbers during April. Data from boat-based surveys recorded guillemots widely across the surveyed areas and land-based observations recorded most guillemots from between 1.5 km and 4.5 km from the coast.

No counts during any surveys undertaken across Aberdeen Bay were of national importance.

4.34.4 Species Sensitivities

Qualifying species

There are four SPAs in the region for which guillemot is a qualifying species: Buchan Ness to Collieston Coast, Fowlsheugh, Troup, Pennan and Lion's Heads and Forth Islands SPA.

Flight height

Flight heights obtained from boat-based surveys undertaken in Aberdeen Bay recorded 1,631 guillemots in flight of which 99.4% were recorded as flying below 25 m and therefore not at risk of collision.

Modelling of flight heights based on 36,000 guillemots for which flight heights have been recorded predicts approximately 4% of flights at above 20 m (Cook *et al.* 2012).

Collision risk

Results from site specific monitoring using boat-based and land-based surveys and other data sources (e.g. NESBR) indicate that guillemots are widespread and frequent within Aberdeen Bay and occur throughout the area.

In order to determine potential effects of collision on guillemot a collision risk assessment has been undertaken (Appendix A1).

The CRM predicts between zero and nine guillemots may collide with the proposed development depending on the avoidance rate selected and use of site specific or generic modelled data.

Table 4-71: Guillemot predicted collision mortalities per year.

Rochdale	Flight height data source	Avoidance rate (%)			
		95.0	98.0	99.0	99.5
Original	EOWDC	1 +/- 1.49	1 +/- 0.60	0 +/- 0.30	0 +/- 0.15
	Generic	9 +/- 10.10	4 +/- 4.04	2 +/- 2.02	1 +/- 1.01
Revised	EOWDC	1 +/- 1.49	0 +/- 0.60	0 +/- 0.30	0 +/- 0.15
	Generic	8 +/- 10.10	3 +/- 4.04	2 +/- 2.02	1 +/- 1.01

Based on the precautionary avoidance rate of 98% and the more precautionary flight heights reported in Cook *et al*. (2012) it is predicted that a up to 3 collisions per year may occur (Table 4-71).

The annual mortality rate for guillemot is 5.4% (BTO 2011). Consequently, out of a peak regional population of 5,313 individuals (Figure 4-77) an annual mortality of 287 guillemot, may be predicted. Therefore, 1% of the baseline mortality is 3 birds per year. It is therefore possible that the proposed development may increase the baseline mortality rate by 1% per year.

The Buchan Ness to Collieston Coast SPA lies approximately 9.5 km away from the proposed development and holds 19,296 individual guillemots on the latest counts in 2007. The colony has an annual mortality of 1,041 guillemots. It is likely that the majority of guillemots within Aberdeen Bay during the breeding period are associated with this colony. The results from the collision risk modelling which predict an annual mortality of up to three guillemots per year indicate that there will not be an adverse effect on guillemot associated with the SPA based on the precautionary assumption that an increase of 1% above baseline mortality could be adverse, i.e. if more than ten guillemots a year collide with the turbines.

The Fowlsheugh SPA lies 31 km away from the proposed development and holds 50,566 guillemots based on latest counts. Therefore, the annual mortality rate is 2,730 birds per year. Based on the results from the collision risk modelling it is concluded that even if all the guillemots at risk of collision are from Fowlsheugh there will not be an adverse effect on the SPA population.

Troup Pennan and Lion's Heads SPA is 74 km to the north of the proposed development and, based on the latest counts holds 16,325 guillemots and therefore an annual mortality rate of 881 guillemots. The results of the collision risk modelling indicate that there will not be an adverse effect on guillemots associated with this SPA.

The Forth Islands SPA is approximately 124 km away and holds 16,888 guillemots therefore an annual mortality rate of 912 guillemots. Should the whole of the population in the Firth of Forth SPA fly through the proposed development area then the collision risk modelling predicts there will not be an adverse effect on the population due to collision.

Based on the results the very low risk of collision it is concluded that the potential effect from collision risk is temporally long-term and of negligible magnitude and minor significance.

Barrier effect

Studies undertaken in Sweden and Denmark indicate that there is some potential for a barrier effect to occur with a reduced number of birds crossing the constructed wind farms (Petersen *et al* 2006; Pettersson 2005, Zucco *et al*. 2006).

During the breeding season it is predicted that there may be regular flights to and from colonies some of which will intersect the proposed development area. The distance guillemot's forage varies depending upon the availability of suitable prey and at what stage during the breeding season they are. The mean maximum foraging range is 84.2 km but the mean range is 38 km during incubation and 5 km during chick rearing (Thaxter *et al*. 2012). Should a barrier effect occur with guillemots from either Fowlsheugh or Buchan Ness to Collieston Coast SPAs making daily movements from one location to another around the proposed development area then they may incur an additional flight distance of up 3.2 km each way, or a total of 6.4 km. This may increase the daily energy expenditure to between 2.0% and 2.5% (Speakman, Gray and Furness 2009).

The location and size of the proposed development is such that it will only occupy a relatively small zone through which birds may avoid flying. No significant concentrations of guillemots were recorded in the vicinity of the proposed development and therefore it is not considered to be a particularly favourable area for foraging. Data from boat-based surveys indicate that greatest densities during the breeding season occur to the north of the proposed EOWDC and in closer proximity to the Buchan Ness to Collieston Coast SPA (Figure 4-74). Regular daily movements by individual birds that could cause an incremental increase in distance of foraging flights on a daily basis is not predicted to occur, i.e. birds from colonies will forage over a wider area and will not need to detour around the proposed development on a regular daily basis.

Based on the above, it is concluded that the potential incremental increases in foraging distances will be temporally long-term and of negligible magnitude and not cause an adverse effect or significant impact on guillemots.

Displacement

Peak guillemot densities within the surveyed area that includes the proposed EOWDC site was 23.9 birds/km^2 during the breeding season (Figure 4-79).

This was a peak density obtained in Year 1 and is considerably greater than those obtained in Year 2 when the peak density in the North strata was 2.74 birds/km^2. Based on the peak densities recorded in Year 1, should there be a total displacement of guillemot from within the proposed development area then it is predicted that up to 101 guillemots may be displaced from the proposed development area during periods of peak density and 772 if complete displacement occurs at peak densities out to 2 km.

A range of potential displacement impacts have been assessed based on between 0% and 100% displacement and 0% and 100% mortality within the proposed development area only and out to 2 km.

Guillemots were considered to be at moderate risk of displacement in the review undertaken by Langston on the potential impacts of wind farms (Langston 2010). Based on this review a moderate displacement of between 40% and 60% of guillemots has been considered for this assessment (Table 4-72 and Table 4-73).

Table 4-72: Potential number of guillemots displaced with the proposed development area.

Mortality	Displacement		
	40%	50%	60%
0%	0	0	0
10%	4.08	5.1	6.12
20%	8.16	10.2	12.24
30%	12.24	15.3	18.36
40%	16.32	20.4	24.48
50%	20.4	25.5	30.6
60%	24.48	30.6	36.72
70%	28.56	35.7	42.84
80%	32.64	40.8	48.96
90%	36.72	45.9	55.08
100%	40.8	51	61.2

Based on the assumptions made that there may be up to 50% displacement then between 5 and 51 guillemots may be at increased risk of mortality due to displacement from the proposed development area alone.

Table 4-73: Potential number of guillemots displaced with the proposed development area plus 2 km buffer area.

Mortality	Displacement		
	40%	50%	60%
0%	0	0	0
10%	30.88	38.6	46.32
20%	61.76	77.2	92.64
30%	92.64	115.8	138.96
40%	123.52	154.4	185.28
50%	154.4	193	231.6
60%	185.28	231.6	277.92
70%	216.16	270.2	324.24
80%	247.04	308.8	370.56
90%	277.92	347.4	416.88
100%	308.8	386	463.2

Based on the assumptions made that there may be up to 50% displacement then between 38 and 386 guillemots may be at increased risk of mortality due to displacement should displacement occur out to 2 km.

Should a total of 386 guillemots be displaced this is equivalent of 3.1% of the regional SPA population (Troup Head to St Abb's Head to Fast Castle) and 0.04% of the Scottish population.

There are five SPAs within the maximum foraging range of guillemots. However, there are only two for which there is potentially high connectivity between birds occurring within the proposed development area and the breeding colonies: Buchan Ness to Collieston Coast SPA and Fowlsheugh SPA. There are no data available to determine what proportion of birds occurs within the area from each of the five colonies. However, assuming that the ratio of birds occurring from each colony within the proposed development area is directly proportionate to the distance from the colony then the number of birds potentially displaced from each colony can be estimated (Table 4-74).

Table 4-74: Predicted number of displaced guillemots at each SPA with a potentially high degree of connectivity.

SPA colony	Guillemot		
	Distance to colony (km)	Number of displaced birds predicted	% of SPA population
Buchan Ness to Collieston	9.5	30 - 298	0.15 - 1.5
Fowlsheugh	32	9 - 88	0.02 - 0.2

Based on this assumption between 0.15% and 1.5% of the Buchan Ness to Collieston Coast SPA guillemot population may be displaced and less than 0.2% of the Fowlsheugh SPA population.

Site specific surveys recorded guillemots throughout the survey area and no specific concentrations were detected within the area of the proposed development, although densities tended to be higher to the north (Appendix B). Density surface modelling undertaken indicated that proposed development was not used significantly more by guillemot than other areas and should there be a displacement effect, guillemots will be able to utilise other areas. It is predicted, based on the recorded distribution and densities of guillemot that in the event of any displacement there will not be a significant negative impact on guillemots.

Post-construction monitoring undertaken at Horns Rev offshore wind farm has indicated that displacement of guillemots can occur. However, results from other operating wind farms have not shown a total displacement of guillemots. Guillemots have been recorded at the constructed Kentish Flats offshore wind farm but in reduced numbers (Gill *et al.* 2008). No displacement effects have been recorded from Egmond aan Zee offshore wind farm or Bligh Bank (Lindeboom *et al.* 2011; Degraer *et al.* 2011). There is therefore evidence from constructed offshore wind farms to suggest that significant displacement of guillemots from within the EOWDC area will not occur.

Based on the evidence from existing offshore wind farms it is predicted that displacement is unlikely to occur. However, should it do so the potential impact from displacement may be temporally long-term, of low magnitude of minor significance based on peak densities of guillemots recorded from boat-based surveys.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on guillemots.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth. The only data available are from the Beatrice Demonstrator Project that recorded 19 guillemots over a period of 12 months pre-construction surveys and from the Beatrice offshore wind farm that recorded 9,139 guillemots (BOWL 2012; Talisman 2005). Guillemots recorded in the Moray Firth may originate from a number of SPAs that are beyond the mean maximum foraging of guillemot with respect to the location of the proposed EOWDC, e.g. East Caithness Cliffs, North Caithness Cliffs and Hoy SPAs. Therefore, there will not be an in-combination impact with guillemots from those SPAs.

Data from other proposed offshore wind farms are not available to determine the number of guillemots that may be present in the planned development areas. Consequently, it is not possible to determine whether there will be a cumulative or in-combination impact arising from all the proposed plans. However, although the developments are within the potential foraging ranges of guillemots from a number of SPAs the, relatively far, distance the proposed development is from the other planned offshore wind farms and its relatively small scale reduces the risk of a potentially significant cumulative or in-combination effect. Any cumulative impacts, should they occur will be negligible in magnitude and of minor significance.

Table 4-75: Summary of significance of potential impacts on guillemot.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	High	Negligible	Medium	Negligible
Operation	Collision	Very High	Negligible	Long-term	Minor
	Displacement	High	Low	Long-term	Minor
	Barrier	Medium	Negligible	Long-term	Negligible
Decommissioning	Displacement	High	Negligible	Medium	Negligible
Cumulative	All	Very High	Negligible	Long-term	Minor

4.34.5 Conclusions

Habitats Appraisal

Based on site specific data and the broad distribution of guillemots in Aberdeen Bay plus evidence from existing offshore wind farms indicating a very low collision risk and recognising that there is potential for some but not total avoidance and potentially some displacement, there will not be any adverse effects on the SPAs for which guillemot is a qualifying species.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental effect arising from the proposed development on guillemots.

4.35 Razorbill (*Alca torda*)

4.35.1 Protection and Conservation Status

The razorbill is listed in Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.35.2 Background

Razorbill		
GB population	Breeding: 110,000 prs.	BTO 2011
Scottish population	Breeding: 93,300 prs. Winter: 50,000 – 250,000 ind.	Forrester *et al.* 2007
International threshold	Unknown	-
GB threshold	2,200 ind.	1% of GB Pop[n]
Designated east coast sites where species is a noted feature	Fowlsheugh: 4,632 ind. (2009) Firth of Forth: 3,464 ind. Troup Pennan and Lion's Heads	SNH 2011b JNCC 2011a
European population estimate	Breeding 430,000 – 770,000 prs. Wintering – >500,000 ind.	Birdlife 2004
European population trend	Status 'secure' Trend 'unknown'	Birdlife 2004
World population	610 – 630,000 prs.	Mitchell *et al* 2004

The global distribution of razorbill is restricted to the North Atlantic and adjacent waters of the Arctic. In the breeding season adult razorbills concentrate in shallow coastal waters at or near breeding colonies, which are usually situated on steep cliffs, often in the vicinity of guillemots (BirdLife International 2012; Snow and Perrins 1998). Relatively little is known about movements of razorbills away from their breeding colonies, although they are believed to be more southerly than guillemots (Wernham *et al*. 2002). During the winter, razorbills can occur in Firths and larger estuaries and shallow marine areas such as St. Andrews Bay (Forrester *et al.* 2007). Razorbills feed chiefly on fish, with some invertebrates. Sandeels are a favoured prey item, which they catch by underwater pursuit after diving from the surface (Snow and Perrins 1998).

There is an estimated 110,000 pairs of razorbill nesting in Britain of which 93,000 pairs occur in Scotland and approximately 12,000 individuals breed within the three main colonies in North-east Scotland (Paterson 2011b; JNCC 2011a).

Table 4-76: Number of Razorbills at the three main breeding colonies in North-east Scotland.

Colony	Year	No. of Individuals	% Change
Fowlsheugh	1999	6,362	-27%
	2009	4,632	
Boddam – Collieston	2001	3,044	+37%
	2007	4,179	
Troup Head	2001	4,831	-46%
	2007	2,601	

In North-east Scotland razorbills occur widely across the region, particularly during the breeding season. Peak passage occurs during April with a smaller autumn passage recorded.

Boat-based surveys

Year 1 boat-based surveys recorded razorbills throughout the year and across the whole of the surveyed area. Peak numbers occurred during post-breeding surveys between July and October, particularly to the north of the proposed development area with relatively lower numbers recorded between November and February. Razorbills were recorded within the footprint of the proposed development with peak numbers during the breeding season (Appendix B).

Peak counts in Year 1 were of 378 birds in the 'control' area during July and 273 birds in the proposed EOWDC development area during in August (Figure 4-80).

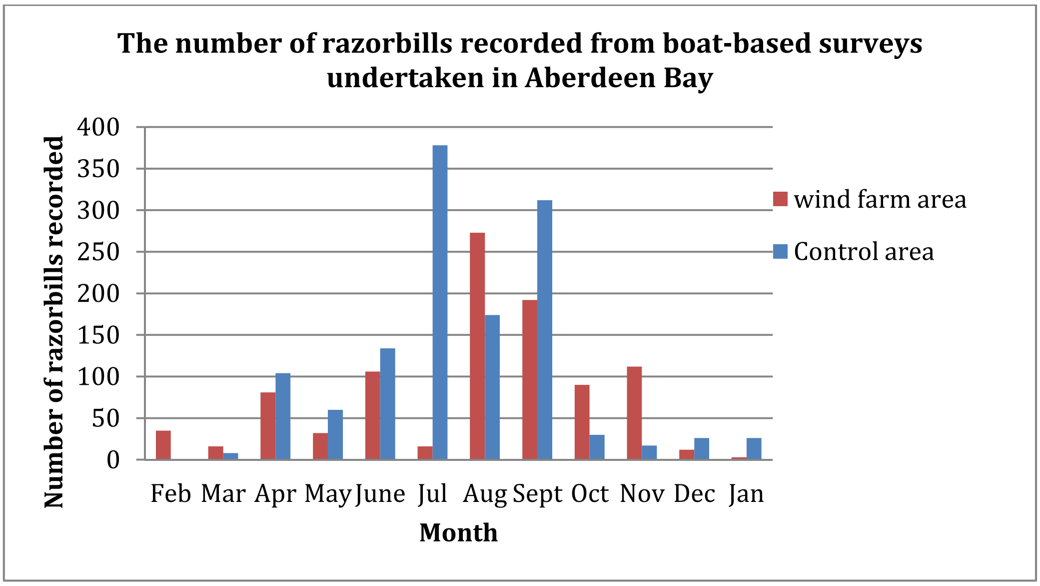


Figure 4-80: Razorbill monthly population estimates in proposed EOWDC and 'control' areas: Boat-based surveys 2007 – 2008.

Estimated abundances using *Distance* sampling on the first years data, estimated peak abundance of razorbill within the area of the proposed development during August with an estimated abundance of 359 birds. The highest abundance was within the 'control' area to the north with a total of 421 birds in October. Very low numbers were recorded throughout the area between January and March (Figure 4-81). Peak densities of razorbills were 8.3 birds/km^2 within the 'control' area during October (Figure 4-82) (SMRU 2011b).

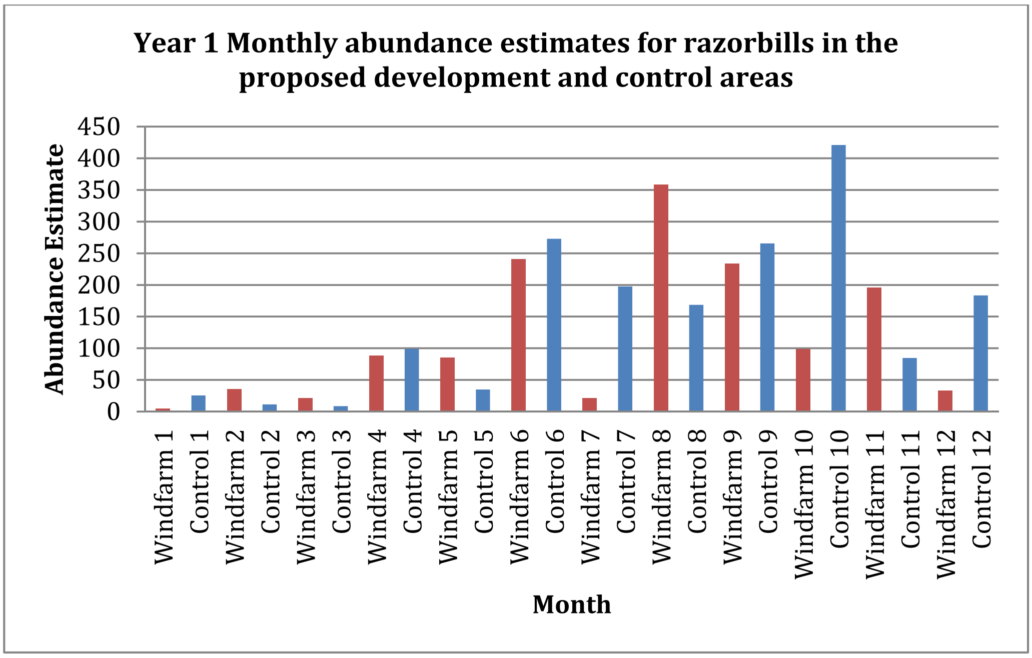


Figure 4-81: Year 1 monthly estimates (+/- SE) of abundance of razorbills in the proposed EOWDC and 'control' areas (Wind farm 1-12 and 'control' 1-12 refers to months).

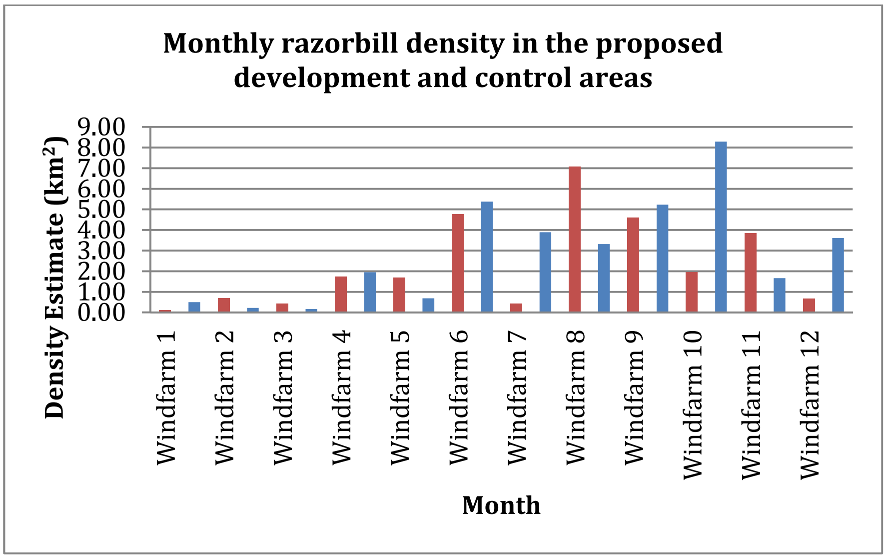


Figure 4-82: Monthly estimates (+/- SE) of density of razorbills in the proposed EOWDC and 'control' areas (Wind farm 1-12 and 'control' 1-12 refers to months).

Boat-based surveys undertaken between August 2010 and August 2011 recorded razorbill throughout the surveyed area throughout the year. Razorbill distributions appeared to be roughly even, with slightly fewer birds offshore. Seasonal trends matched other Auks, with a post-fledging peak in abundance, and lower numbers during the winter (Appendix B).

Density surface modelling undertaken on the Year 2 data indicate highest predicted densities of razorbill to the north of the proposed development area with predicted densities of between 0.8 and 1.0 razorbill per km^2 within the proposed EOWDC (SMRU 2011c). The low numbers of razorbill recorded during the winter surveys meant density surface modelling was unable to be carried out for this period.

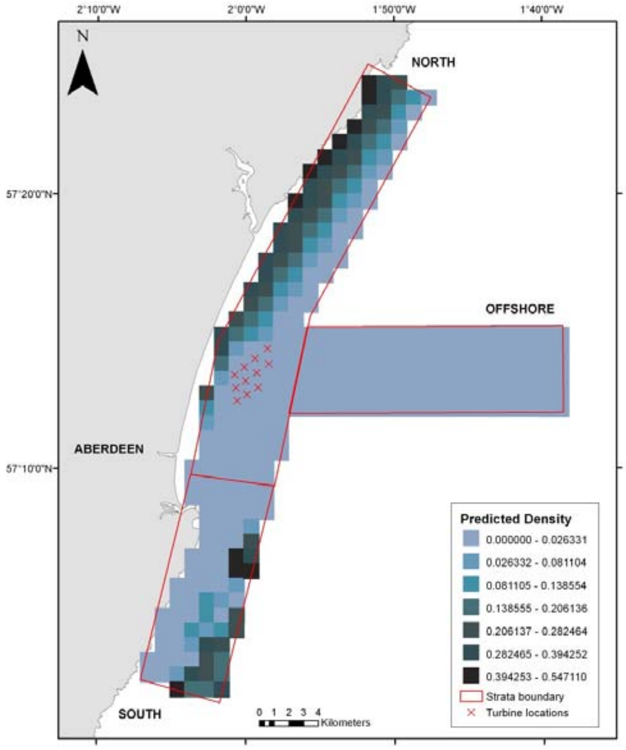


Figure 4-83: Density Surface Model results for razorbill during spring based on analysis of data from September 2010 to August 2011 (SMRU 2011c).

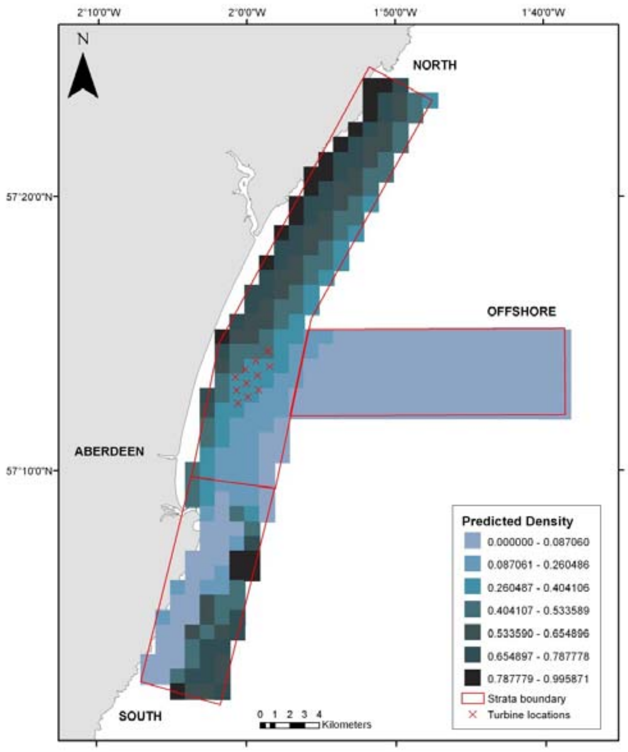


Figure 4-84: Density Surface Model results for razorbill during summer based on analysis of data from September 2010 to August 2011 (SMRU 2011c).

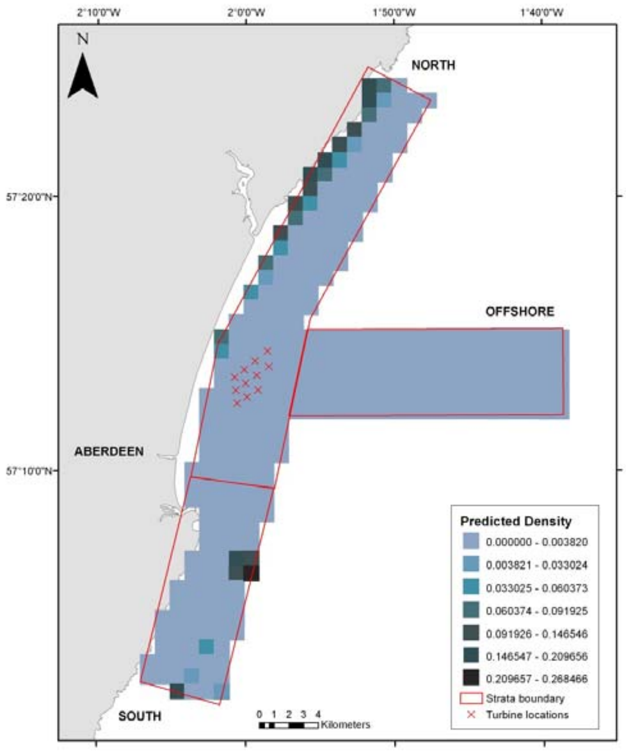


Figure 4-85: Surface Model results for razorbill during autumn based on analysis of data from September 2010 to August 2011 (SMRU 2011c).

Distance modelling undertaken on Year 2 boat-based data recorded peak abundance in the South strata during July with an estimated 1,246 razorbills recorded and a total estimated population within the surveyed area during July of 2,009 individuals. Abundance was generally lower offshore compared to the North and South survey areas. Lowest numbers of razorbill were recorded across all three strata between November and March (Figure 4-86).

Peak densities of razorbill occurred during July in the South strata with a peak of 15 birds/km^2 in July. In the North strata, the area within which the proposed EOWDC may be developed, peak densities also occurred in July at 4.0 birds/km^2 (SMRU 2011c).

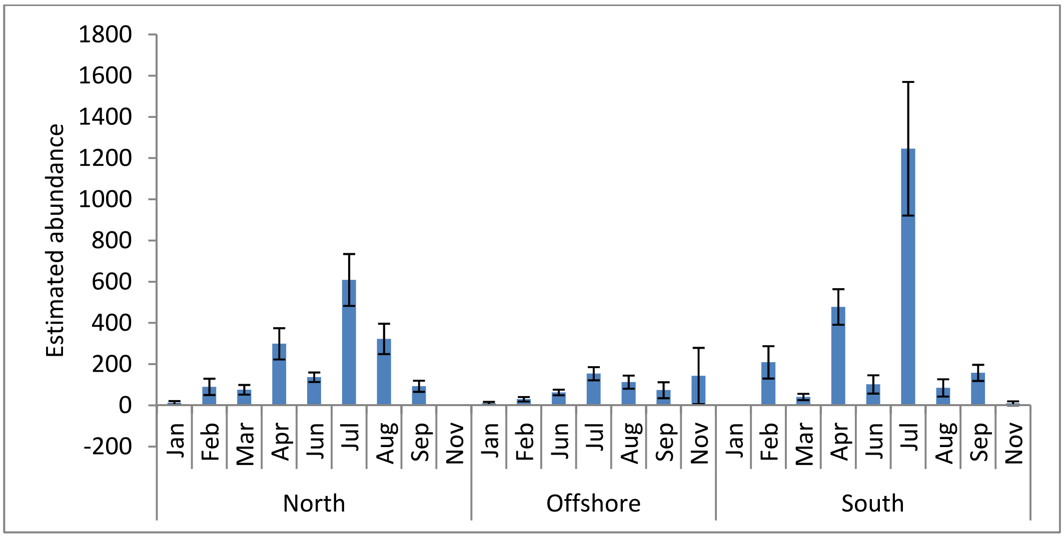


Figure 4-86: Monthly abundance estimates (+/- CV) of razorbill in the South, North and Offshore Strata 2010 and 2011.

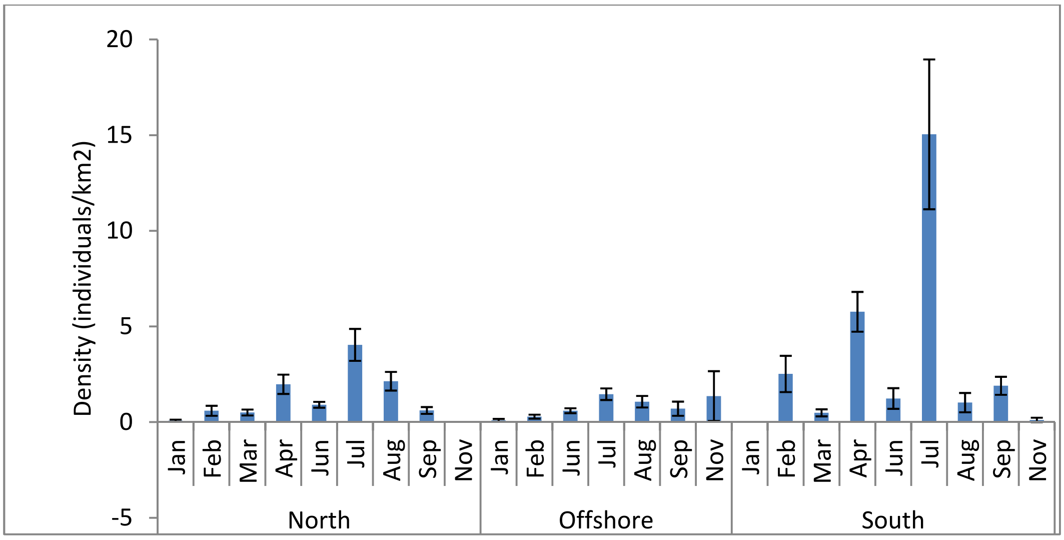


Figure 4-87: Monthly estimates (+/- CV) of density of razorbill in the South, North and Offshore Strata 2010 and 2011.

Year 1 and Year 2 Combined

Due to the numbers of razorbills recorded and the ability to undertake both Distance Modelling and Density Surface Modelling on data collected from Year 1 and Year 2 surveys, it is possible compare densities on a seasonal basis across years (SMRU 2011c). The results indicate that although the densities of razorbills recorded in both years were significantly different with higher densities in Year 1 than in Year 2 the seasonal changes were consistent (Figure 4-88).

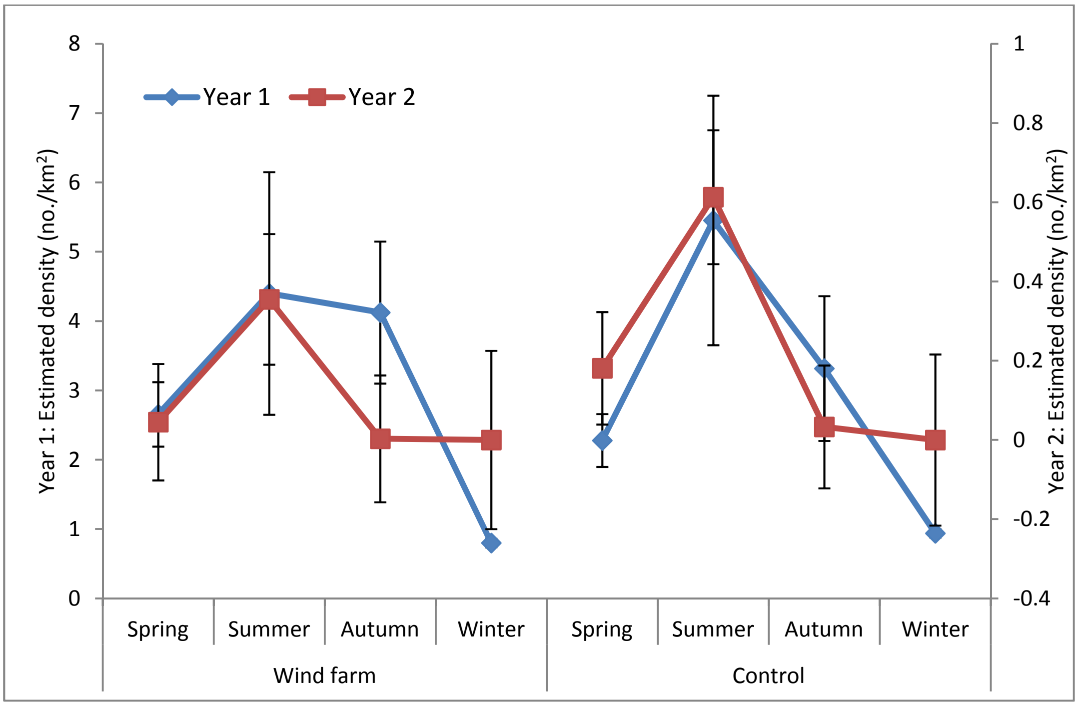


Figure 4-88: Estimated density of razorbill for two study areas used in Year and Year 2 data extracted from Density Surface Models.

Vantage Point surveys

Razorbills were recorded significantly less frequently in Aberdeen Bay than guillemots with a peak of up to seven birds per hour in March 2006 and five birds per hour during September 2007 (EnviroCentre 2007; Alba Ecology 2008a). All birds recorded from shore were flying below 30 m and unlike guillemot, most were flying between 1 and 2 km from shore.

Bird Detection Radar

There were no razorbills recorded during the radar surveys undertaken at Drums and Easter Hatton during October 2005. In April 2007 a total of 12 razorbills were recorded from Blackdog (Simms *et al*. 2007).

4.35.3 Summary of Results

Razorbills were widely recorded across Aberdeen Bay from all surveys. Low numbers were present at the beginning of the year but increased from April onwards. Data from boat-based surveys indicate peak counts in the bay between July and September but also a high count in October. Land based observations recorded peak numbers during April and September.

Data from boat-based surveys recorded razorbills widely across the surveyed areas and land-based observations recorded most birds from between 2.0 km and 4.0 km from the coast.

All but one razorbill recorded in flight from boat-based surveys were flying below 25 m.

No counts during any surveys undertaken across Aberdeen Bay were of national importance.

4.35.4 Species Sensitivities

Qualifying species

There are three SPAs in the region for which razorbill is a qualifying species: Fowlsheugh, Troup, Pennan and Lion's Head and Forth Islands SPA.

Flight height

Flight heights obtained from boat-based surveys undertaken in Aberdeen Bay recorded 668 razorbills in flight of which one was recorded as flying above 25 m and therefore at risk of collision. 99.9% of all flights were below 25 m.

Elsewhere out of 13,070 razorbills for which flight heights have been recorded modelling predicts that 6.7% of flights will be above 20 m (Cook *et al*. 2012).

Collision risk

Results from site specific monitoring using boat-based and land-based surveys and other data sources (e.g. NESBR; Buckland, Bell and Picozzi 1990) indicate that razorbills are widespread and frequent within Aberdeen Bay and occur in relatively low densities throughout the area.

In order to determine potential effects of collision on razorbill a collision risk assessment has been undertaken (Appendix A1).

The CRM predicts between zero and four razorbills may collide with the proposed development depending on the avoidance rate selected and use of site specific or generic modelled data.

Table 4-77: Razorbill predicted collision mortalities per year.

Rochdale	Flight height data source	Avoidance rate (%)			
		95.0	98.0	99.0	99.5
Original	EOWDC	0 +/- 0.1	0 +/- 0.04	0 +/- 0.02	0 +/- 0.01
	Generic	4 +/- 4.59	2 +/- 1.84	1 +/- 0.92	0 +/- 0.92
Revised	EOWDC	1 +/- 0.1	0 +/- 0.04	0 +/- 0.02	0 +/- 0.01
	Generic	3 +/- 3.77	1 +/- 1.51	0 +/- 0.75	0 +/- 0.38

The number of razorbills predicted to collide is low based on either site specific data or modelled generic data.

Based on the precautionary avoidance rate of 98% and site specific data it is predicted that less than 1 collision per year may occur (Table 4-77).

Based on the low number of predicted collisions it is concluded that the risk of a collision with a turbine is very small and that any collision mortality, should it occur, will be temporally long-term and of negligible magnitude and minor significance and not cause an adverse effect or significant impact to razorbills.

Barrier effect

As with guillemots, studies undertaken in Sweden and Denmark indicate that there is some potential for a barrier effect to occur with a reduced number of guillemots/razorbill crossing the constructed wind farms (Peterson *et al*. 2006).

During the breeding season it is predicted that there may be regular flights to and from colonies some of which will intersect the proposed development area. The distance razorbills forage varies depending upon the availability of suitable prey and at what stage during the breeding season they are. Mean maximum foraging range is 48.5 km (Thaxter *et al*. 2012). Should a barrier effect occur with razorbills from Fowlsheugh SPA making daily movements from one location to another around the proposed development area then they may incur an additional flight distance of up 3.2 km each way, or a total of 6.4 km. This may increase the daily energy expenditure to between 2.0% and 2.5% (Speakman, Gray and Furness 2009).

The location and size of the proposed development is such that it will only occupy a relatively small zone through which birds may avoid flying. No significant concentrations of razorbills were recorded in the vicinity of the proposed development and therefore it is not considered to be a particularly favourable area for foraging. Regular daily movements by individual birds that could cause an incremental increase in distance of foraging flights on a daily basis is not predicted to occur, i.e. birds from colonies will forage over a wider area and will not need to detour around the proposed development on a regular daily basis.

Based on the above it is concluded that the potential incremental increases in foraging distances will be temporally long-term and of negligible magnitude and significance and not cause an adverse effect or significant impact on razorbills.

Displacement

Peak razorbill densities within the surveyed area that includes the proposed EOWDC site was 7.06 birds/km^2 during the post-breeding season in Year 1 (Figure 4-81) and 4.0 in July in Year 2. Results from Density Surface modelling comparing both years provides a peak estimate of 4.0 razorbills per km^2. For the purposes of this assessment the peak density of 7.0 birds/km^2 has been used.

A range of potential displacement impacts have been assessed based on between 0% and 100% displacement and 0% and 100% mortality within the proposed development only and out to 2 km.

Razorbills were considered to be at moderate risk of displacement in the review undertaken by Langston on the potential impacts of wind farms (Langston 2010). Based on this review a moderate displacement of between 40% and 60% of razorbills has been considered for this assessment (Table 4-78).

Table 4-78: Potential number of razorbills displaced from the proposed development area.

Mortality	Displacement		
	40%	50%	60%
0%	0	0	0
10%	1.2	1.5	1.8
20%	2.4	3	3.6
30%	3.6	4.5	5.4
40%	4.8	6	7.2
50%	6	7.5	9
60%	7.2	9	10.8
70%	8.4	10.5	12.6
80%	9.6	12	14.4
90%	10.8	13.5	16.2
100%	12	15	18

Based on the assumptions made that there may be up to 50% displacement then between 1 and 15 razorbills may be impacted due to displacement from within the proposed development area alone.

Table 4-79: Potential number of razorbills displaced from the proposed development area plus 2 km buffer area.

Mortality	Displacement		
	40%	50%	60%
0%	0	0	0
10%	10.32	12.9	15.48
20%	20.64	25.8	30.96
30%	30.96	38.7	46.44
40%	41.28	51.6	61.92
50%	51.6	64.5	77.4
60%	61.92	77.4	92.88
70%	72.24	90.3	108.36
80%	82.56	103.2	123.84
90%	92.88	116.1	139.32
100%	103.2	129	154.8

Based on the assumptions made that there may be up to 50% displacement then between 13 and 129 razorbills may be impacted due to displacement should displacement occur out to 2 km.

There is one SPA for which there is potentially high connectivity between birds occurring within the proposed development area and the breeding colony (Fowlsheugh SPA) and one SPA where razorbills breed but are not a qualifying species (Buchan Ness to Collieston Coast SPA). There are no data available to determine what proportions of birds occur within the area from each of the colonies. However, assuming that the ratio of birds occurring from each colony within the proposed development area is directly proportionate to the distance from the colony (Table 4-79) then the number of birds potentially displaced from each colony may be estimated (Table 4-80.)

Table 4-80: Predicted number of displaced razorbill at each SPA with a potentially high degree of connectivity (based on 2 km displacement).

SPA colony	Razorbill		
	Distance to colony (km)	Number of displaced birds predicted	% of SPA population
Buchan Ness to Collieston	9.5	9 – 99	0.2 – 2.3
Fowlsheugh	32	3 - 30	0.06 – 0.6

Site specific surveys recorded razorbills throughout the survey area and no specific concentrations were detected within the area of the proposed development, although densities tended to be higher to the north and south (Figure 4-83 to Figure 4-85).

Density surface modelling undertaken indicates that proposed development area is not used significantly more by razorbill than other areas of Aberdeen Bay and consequently should there be a displacement effect, razorbills will be able to locate elsewhere. It is predicted, based on the recorded distribution and densities of razorbills and the numbers predicted to be displaced that in the event of any displacement occurring the effects will be temporally long-term and of negligible magnitude and minor significance.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on razorbills.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth. The only data available are from the Beatrice Demonstrator Project, which recorded one razorbill over a period of 12 months pre-construction surveys and from the proposed Beatrice offshore wind farm, which recorded 1,721 razorbills over a period of two years (BOWL 2012; Talisman 2005). Razorbills recorded in the Moray Firth may originate from a number of SPAs that are beyond the mean maximum foraging of razorbill with respect to the location of the proposed EOWDC, e.g. East Caithness Cliffs, North Caithness Cliffs and Hoy SPAs. Therefore, there will not be an in-combination impact with razorbills from those SPAs.

Data from other proposed offshore wind farms are not available. Consequently, it is not possible to determine whether there will be a cumulative or in-combination impact arising from all the proposed plans. However, although the developments are within the potential foraging ranges of razorbills from a number of SPAs the relatively far distance the proposed development is from the other planned offshore wind farms and its relatively small scale reduces the risk of a potentially significant cumulative or in-combination effect. Any cumulative impacts, should they occur will be negligible in magnitude and of minor significance.

Table 4-81: Summary of significance of potential impacts on razorbill.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	High	Negligible	Medium	Negligible
Operation	Collision	Very High	Negligible	Long-term	Minor
	Displacement	High	Low	Long-term	Minor
	Barrier	Medium	Negligible	Long-term	Negligible
Decommissioning	Displacement	High	Negligible	Medium	Negligible
Cumulative	All	Very High	Negligible	Long-term	Minor

4.35.5 Conclusions

Habitats Appraisal

Based on site specific data and broad distribution of razorbills in Aberdeen Bay plus evidence from existing offshore wind farms indicating a very low collision risk and recognising that there is potential for some but not total avoidance and potentially some displacement it is predicted that there will not be any adverse effects on the SPA for which razorbill is a qualifying species.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental effect arising from the proposed development on razorbills.

4.36 Guillemot/Razorbill (*Uria aalge/Alca torda*)

4.36.1 Background

Guillemot and razorbill may be difficult to separate in the field and consequently a proportion of birds are not identified to either species but are instead recorded as either guillemot or razorbill.

Boat-based surveys

Data from boat-based surveys undertaken between February 2007 and January 2008 indicate a similar pattern of distribution for guillemot/razorbill as was found for each individual species. Peak numbers occurred during July with an estimated 4,058 birds recorded in the 'control' area to the north and 1,620 in the wider proposed development area. Outwith the peak post-breeding period there was an estimated density of less than 6 birds/km^2 from November through to March. Throughout the year densities and abundance were greater within the 'control' area than within the proposed development area (Table 4-82, Figure 4-81 and Figure 4-82).

Within the footprint of the proposed development relatively low numbers of guillemots/razorbills were recorded particularly during the breeding and post-breeding seasons.

Table 4-82: Monthly estimates of density and abundance of guillemots/razorbills and individuals not identified to either species in the proposed EOWDC and 'control' areas in Year 1.

Month	Location	Density Estimate (km^2)	SE	Estimated Abundance	SE	No. Observations
January	EOWDC	2.154	0.509	109	25.9	30
	Control	2.908	0.546	148	27.7	45
February	EOWDC	6.135	0.751	312	38.2	169
	Control	1.662	0.285	84	14.5	52
March	EOWDC	1.486	0.389	75	19.7	23
	Control	3.262	0.598	166	30.4	43
April	EOWDC	5.147	0.790	261	40.2	138
	Control	10.377	1.481	527	75.2	260
May	EOWDC	8.001	1.147	406	58.2	85
	Control	12.646	1.856	642	94.3	151
June	EOWDC	14.219	2.607	722	132.4	109
	Control	20.070	2.828	1,020	143.7	180
July	EOWDC	31.882	4.153	1620	211.0	192
	Control	79.886	10.083	4,058	512.2	330
August	EOWDC	20.613	3.916	1047	198.9	104
	Control	29.480	5.655	1,498	287.2	178
September	EOWDC	17.920	2.500	910	127.0	180
	Control	26.274	2.410	1,335	122.4	221
October	EOWDC	17.839	1.854	906	94.2	187
	Control	6.010	0.867	305	44.0	77
November	EOWDC	5.447	0.602	277	30.6	55

Month	Location	Density Estimate (km^2)	SE	Estimated Abundance	SE	No. Observations
	Control	2.659	0.515	135	26.2	29
December	EOWDC	2.585	0.714	131	36.3	38
	Control	1.635	0.362	83	18.4	14

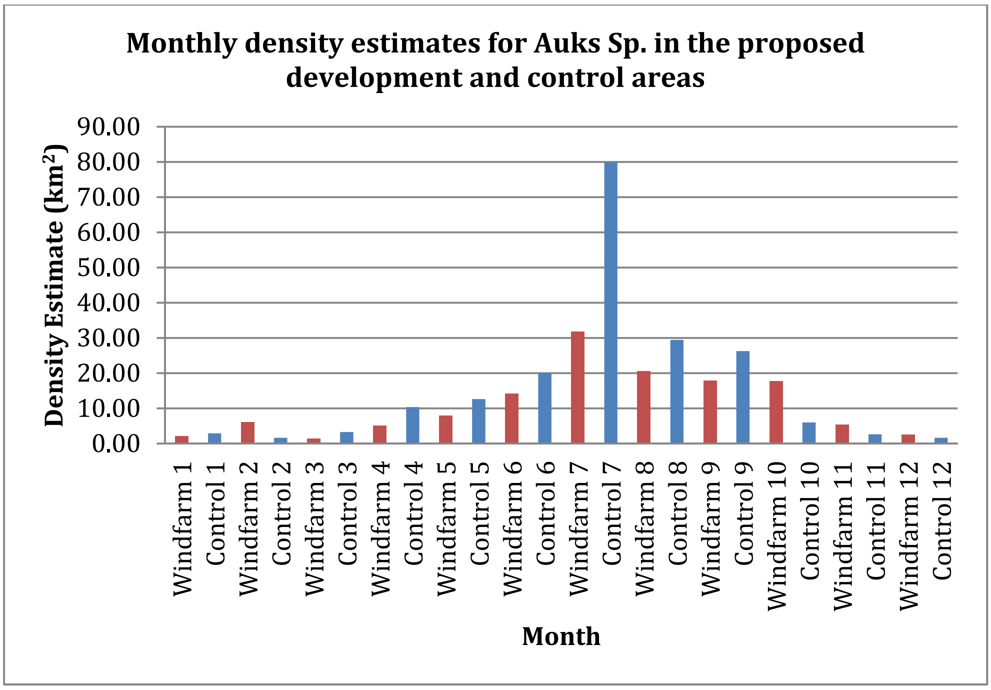


Figure 4-89: Monthly estimates (+/- SE) of density of guillemots, razorbills and individuals not identified to species in the proposed EOWDC and 'control' areas ('Windfarm' 1-12 and 'control' 1-12 refers to months).

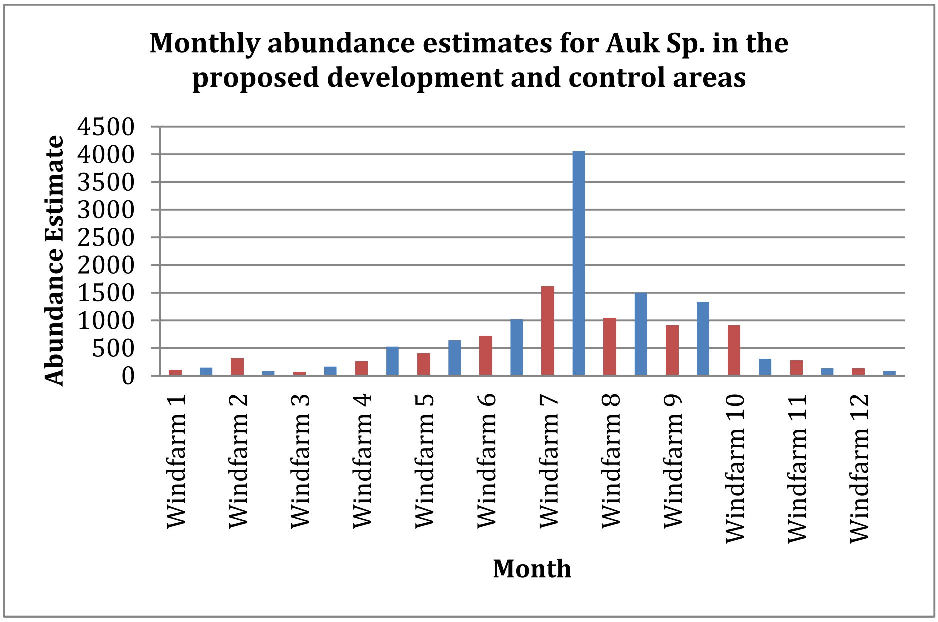


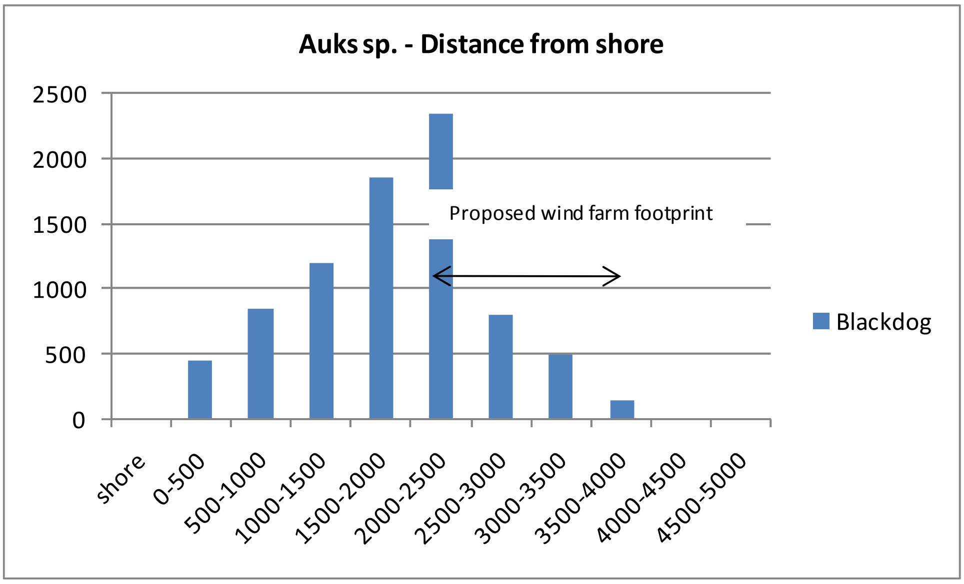
Figure 4-90 Monthly estimates (+/- SE) of abundances of guillemots, razorbills and individuals not identified to species in the proposed EOWDC.

Vantage Point surveys

Unidentified Auks were recorded throughout the year during vantage point surveys. Peak numbers occurred during April when up to 600 birds an hour were recorded passing Drums and November when up to 120 birds per hour were recorded passing Balmedie. Aside from these two peak counts numbers passing all vantage point sites were considerably lower and often less than 10 birds per hour at other sites during the same period (Alba Ecology 2008a). During the breeding season the numbers of unidentified Auks was lower than during the post-breeding season.

Bird Detection Radar

A total of 38 Auks were not identified to species level from observations undertaken during surveys at Drums and Easter Hatton during October 2005. During the seventeen days of radar surveys undertaken in April 2007, a total of 7,787 unidentified Auks were recorded with a mean passage rate of 153 birds per hour making this the most frequently recorded 'species' during the April surveys. There was a distinct peak of up to 2,500 birds passing per hour on the evening of 12 April (Simms *et al*. 2007). The majority of sightings were within 1.5 km and 3 km from the coast (Figure 4-91).



(Adapted from Simms *et al*. 2007)

Figure 4-91: Distances from shore for Auks Sp. from Blackdog (April 2007).

4.36.2 Summary of Results

Unidentified Auks were widely recorded across Aberdeen Bay from all surveys. Relatively low numbers were present at the beginning of the year but increased from April onwards. Data from surveys indicate peak numbers in the bay during July with a decrease in numbers from August onwards. Significantly more birds were recorded in the 'control' area than within the proposed development area.

Data from boat-based surveys recorded unidentified Auks widely across the surveyed areas and land-based observations recorded most from between 2.0 km and 4.0 km from the coast.

4.36.3 Assessment of impacts

The assessment of impacts on Auk Sp. has been considered within the separate species accounts where the impacts on Auks Sp. are considered the same as those identified to species.

A total of 28,162 guillemots and razorbills were positively identified to species. Of which 83% were guillemots and 17% were razorbills. Consequently of the 2,616 unidentified guillemot or razorbill 2,172 were guillemot and 444 were razorbill.

4.37 Atlantic Puffin (*Fratecula arctica*)

4.37.1 Protection and Conservation Status

The (Atlantic) puffin is listed in Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.37.2 Background

Puffin		
GB Population	Breeding: 579,000 prs.	BTO 2011
Scottish population	Breeding: 493,000 prs. Winter: est. 20,000 ind.	Forrester *et al.* 2007
International threshold	Unknown	-
GB threshold	10,400 ind.	1% of GB Pop^{n}
Designated east coast sites where species is a noted feature	Firth of Forth (58,867 AoN)	SNH 2011b JNCC 2011a
European population estimate	Breeding 5,700,000 – 7,300,000 prs. Wintering – unknown	Birdlife 2004
European population trend	Status 'depleted' Trend 'unknown'	Birdlife 2004
World population	5,500,000 – 6,600,000 prs.	Mitchell *et al* 2004

Puffins are restricted to the North Atlantic and adjacent waters of the Arctic, with the species main stronghold in Iceland and north Norway. Puffins remain offshore until the breeding season when they move inshore and start attending colonies during early spring. The species is highly colonial, with pairs typically nesting in underground burrows dug in the soil of offshore islands (BirdLife International 2012). Following breeding, puffins leave the colonies and disperse widely to offshore waters. Puffins mainly feed on fish with sandeels a favoured prey item that they catch by underwater pursuit after diving from the surface (Snow and Perrins 1998).

The UK breeding population is estimated to be approximately 600,000 pairs of which 493,000 are in Scotland and 2,500 nest in North-east Scotland (Paterson 2011c).

In North-east Scotland puffins are rarely recorded outwith the breeding season with peak counts past Peterhead of up to 15 birds per hour in June and July (Innes 1990).

Boat-based survey

Unlike guillemots and razorbills, puffins were recorded predominantly in water depths of 30 m or more, with relatively few birds in near-shore waters. There were very few records of puffin between November and February with numbers increasing from March onwards. However, numbers in Aberdeen Bay were still relatively low with peak concentrations during the breeding season near Collieston where small numbers breed. Peak numbers occurred in the post-breeding season between August and October with the majority of birds to the north and very few records within the footprint of the proposed development area (Appendix B).

Puffins were only recorded between May and November with peak counts in the post-breeding season with an estimated population of 700 and 800 birds in the northern survey area during August and September 2010 and 1,347 individuals in offshore waters during August. Within the 'control' area peak abundance occurred during September when 357 individuals were estimated within the 'control' area and 48 were present in the proposed EOWDC development area. Within the proposed EOWDC development area peak numbers of puffin occurred during August and October when peak counts of 175 and 163 respectively were recorded (Figure 4-92 and Figure 4-94).

Peak densities also occurred between August to October when 12.8 birds/km^2 were recorded in offshore areas during August and 7 birds/km^2 during October in the 'control' area. Within the proposed development area a peak density of 3.4 birds/km^2 was recorded in August.

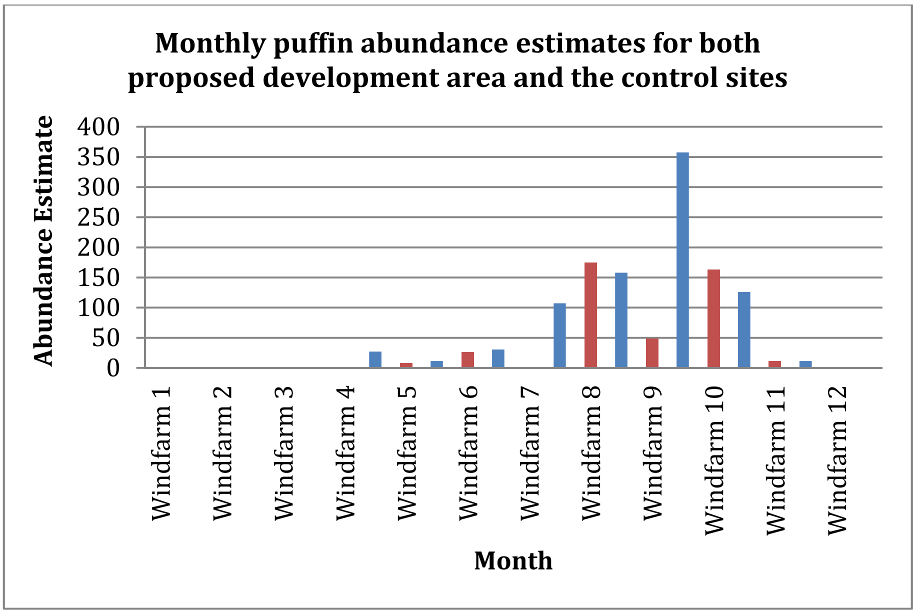


Figure 4-92: Monthly estimates (+/- SE) of abundance of puffins in the proposed EOWDC and 'Control' areas; February 2007 to January 2008 ('Windfarm' 1-12 and 'Control' 1-12 refers to months).

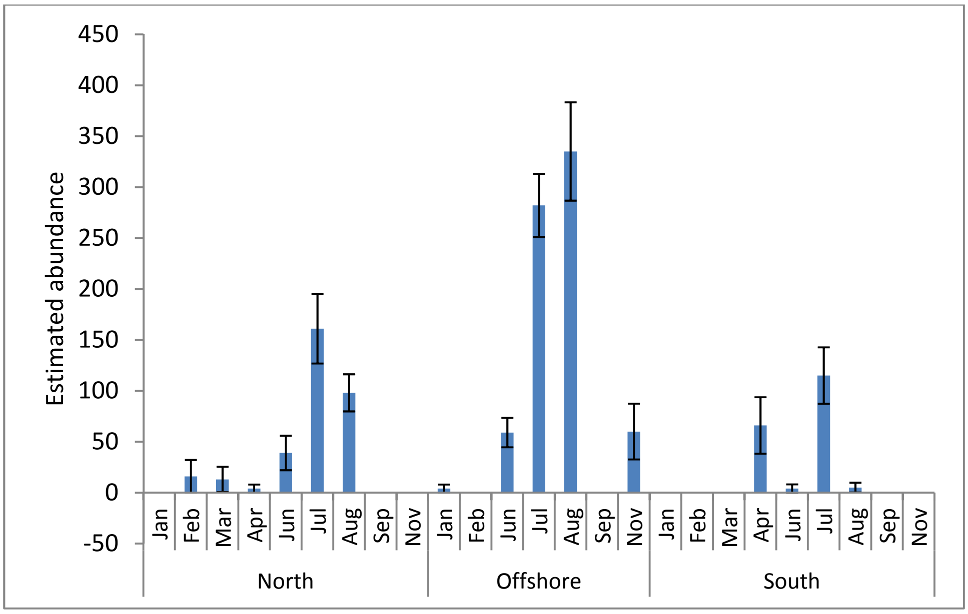


Figure 4-93: Monthly estimates (+/- SE) of abundance of Atlantic Puffin in the South, North and Offshore Strata; August 2010 to August 2011.

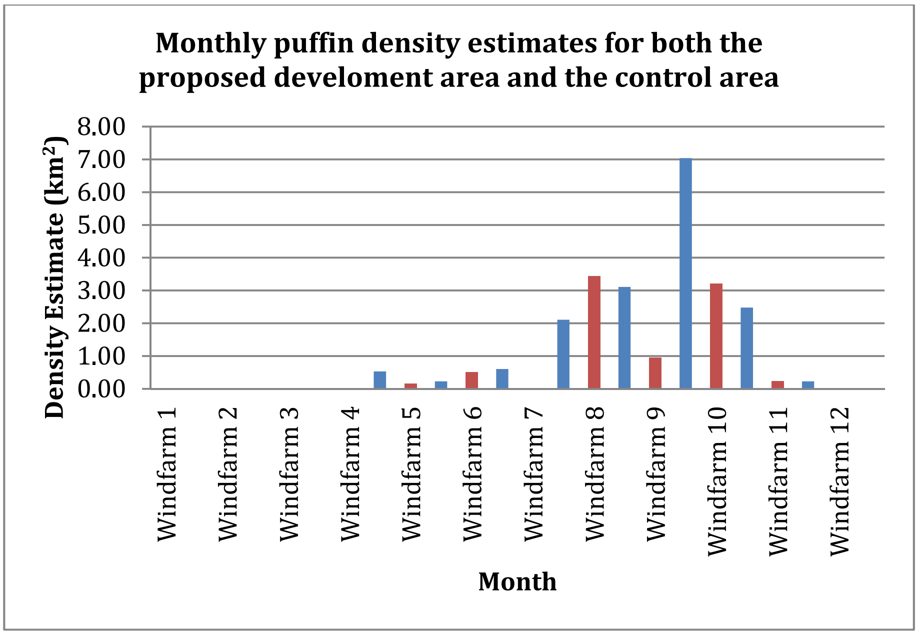


Figure 4-94: Monthly estimates (+/- SE) of density of puffins in the proposed EOWDC and 'control' areas February 2007 to January 2008 ('Windfarm' 1-12 and 'Control' 1-12 refers to months).

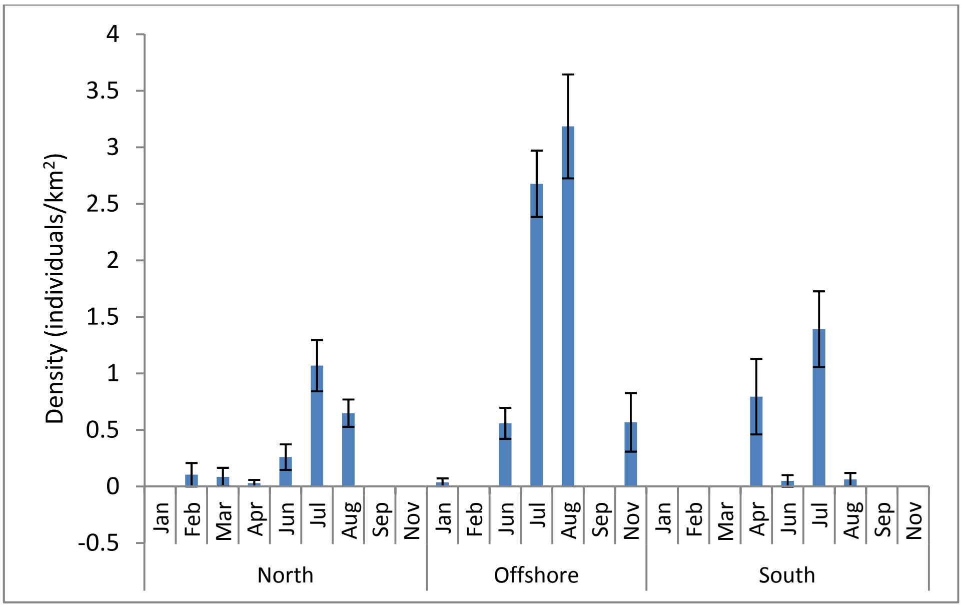


Figure 4-95: Monthly estimates (+/- SE) of density of Atlantic Puffin in the South, North and Offshore Strata; August 2010 to August 2011.

Vantage Point surveys

In Aberdeen Bay puffins were scarce during the winter period with only one sighting between October 2006 and March 2007. Between April and September low numbers of puffin were recorded with a passage of two birds per hour and a peak of three birds per hour in April. All sightings were of birds flying below 30 m and between 1 km and 3 km from shore.

Bird Detection Radar

One puffin was recorded during radar studies in October 2005 (Walls *et al.* 2005).

4.37.3 Summary of Results

Puffins were widely recorded across Aberdeen Bay from all surveys. No puffins were recorded between December and March and relatively low numbers were recorded until July when the number of puffins recorded increased with a peak during the post-breeding period. Peak numbers of puffins during July and September were recorded within the 'control' area whereas in August and October peak numbers were within the proposed development area.

Of those recorded in flight, all puffins recorded during boat-based and land-based surveys were recorded as flying below 30 m.

No counts of puffin from any of the surveys undertaken within Aberdeen Bay were of national importance.

4.37.4 Species Sensitivities

Qualifying species

The only SPA in the region for which puffin is a qualifying species is the Forth Islands SPA where 58,867 pairs of puffins nest on the Isle of May.

Flight height

Flight heights obtained from boat-based surveys undertaken in Aberdeen Bay recorded 169 puffins in flight, none of which all were recorded as flying above 25 m and therefore at no risk of collision.

Elsewhere in the UK very few puffins have been recorded in flight and all have been below turbine height (n=35).

Collision risk

Results from site specific monitoring using boat-based and land-based surveys and other data sources (e.g. NESBR, Buckland, Bell and Picozzi 1990), indicate that puffins are widespread and frequent within Aberdeen Bay and occur in relatively low densities throughout the area.

No puffins were recorded as flying at rotor height within Aberdeen Bay or from other wind farms and no reports of collisions of puffins have been found. Collision Risk Modelling undertaken on puffin predicts zero collisions per year (Appendix A1). Consequently, it is concluded that the risk of a collision with a turbine is very small and that any collision mortality, should it occur, will be temporally long-term and of negligible magnitude and minor significance and not cause an adverse effect or significant impact to puffins.

Barrier effect

There is little evidence from existing wind farms to determine whether puffins may be impacted by a barrier effect as very few puffins have been reported near to constructed offshore wind farms.

During the breeding season it is predicted that there may be regular flights to and from colonies some of which will intersect the proposed development area. The distance puffins forage varies depending upon the availability of suitable prey and at what stage they are during the breeding season. Maximum foraging ranges are up to 200 km away from the colony, although most foraging ranges will be closer than this with a reported mean maximum range of 62 km and a mean range of 30 km (BirdLife International 2012). Should a barrier effect occur with birds from Fowlsheugh or to the north of Collieston making daily movements from one location to another around the proposed development area then they may incur an additional flight distance of up 3.2 km each way, or a total of 6.4 km. This may increase the daily energy expenditure to between 2.0% and 2.5% (Speakman, Gray and Furness 2009).

The location and size of the proposed development is such that it will only occupy a relatively small zone through which birds may avoid flying. No significant concentrations of puffins were recorded but they did tend to occur further offshore than either guillemot or razorbill and therefore have a higher potential to interact with the proposed development. However, puffins had a wide distribution offshore and regular daily movements by individual birds that could cause an incremental increase in the length of foraging flights on a daily basis is not predicted to occur, i.e. birds from colonies will forage over a wider area and will not need to detour around the proposed development on a regular daily basis.

Based on the above it is concluded that the potential incremental increases in foraging distances will be temporally long-term and of negligible magnitude and significance and not cause an adverse effect or significant impact on puffins.

Displacement

Peak puffin density within the surveyed area that includes the proposed EOWDC site was 3.4 birds/km^2 during August in Year 1 and 1.06 in August in Year 2. For the purposes of this assessment on displacement the peak density of 3.4 birds/km^2 has been used.

Based on the peak densities recorded in Year 1, should there be a total displacement of puffin from within the proposed development area then it is predicted that up to 15 puffins may be displaced from the proposed development area during periods of peak density.

A range of potential displacement impacts have been assessed based on between 0% and 100% displacement and 0% and 100% mortality within the proposed development only and out to 2 km.

Puffins were considered to be at moderate risk of displacement in the review undertaken by Langston on the potential impacts of wind farms (Langston 2010). Based on this review a moderate displacement of between 40% and 60% of puffins has been considered for this assessment (Table 4-83).

Table 4-83: Potential number of puffins displaced from the proposed development area.

Mortality	Displacement		
	40%	50%	60%
10%	0.6	0.75	0.9
20%	1.2	1.5	1.8
30%	1.8	2.25	2.7
40%	2.4	3	3.6
50%	3	3.75	4.5
60%	3.6	4.5	5.4
70%	4.2	5.25	6.3
80%	4.8	6	7.2
90%	5.4	6.75	8.1
100%	6	7.5	9

Based on the assumptions made that there may be up to 50% displacement then between 1 and 8 puffins may be affected due to displacement from with the proposed development area alone.

Table 4-84: Potential number of puffins displaced from the proposed development area plus 2 km buffer area.

Mortality	Displacement		
	40%	50%	60%
10%	4.96	6.2	7.44
20%	9.92	12.4	14.88
30%	14.88	18.6	22.32
40%	19.84	24.8	29.76
50%	24.8	31	37.2
60%	29.76	37.2	44.64
70%	34.72	43.4	52.08
80%	39.68	49.6	59.52
90%	44.64	55.8	66.96
100%	49.6	62	74.4

Based on the assumptions made that there may be up to 50% displacement then between 6 and 62 puffins may be affected due to displacement should displacement occur out to 2 km.

There are no SPAs for which there is potentially high connectivity between puffins occurring within the proposed development area and the breeding colonies. In North-east Scotland a total of 2,500 pairs are estimated to breed (Paterson 2011c). A displacement of up to 62 birds equates to 1.2% of the adult breeding population.

Site specific surveys recorded puffins throughout the survey area and no specific concentrations were detected; although densities tended to be higher further offshore compared to those recorded from the proposed development area. Should there be a displacement effect puffins will be able to forage elsewhere.

Densities of puffins within the proposed development area were not higher than elsewhere and consequently it is not thought that the proposed location is of particular importance for puffin, particularly as densities tended to be higher further offshore and in the 'control' area. Consequently, should displacement occur there are other areas where puffins could relocate and it is predicted that any potential impact caused by displacement will be temporally long-term, of low magnitude and minor significance.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on puffins.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth. The only data available are from the Beatrice Demonstrator Project, which recorded 16 puffins over a period of 12 months pre-construction surveys and the proposed Beatrice offshore wind farm, which recorded 1,389 puffins over a period of two years (BOWL 2012; Talisman 2005).

There are no data available from other planned Round 3 wind farms and those in Scottish Territorial Waters. Consequently, it is not possible to determine whether there will be a cumulative or in-combination impact arising from all the proposed plans. However, although the developments within the Firth of Forth area are within foraging ranges of puffins from the Isle of May the relatively large distance the proposed development is from the other planned offshore wind farms and its relatively small scale reduces the risk of a potentially significant cumulative or in-combination effect.

Table 4-85: Summary of significance of potential impacts on puffin.

Phase	Impact	Sensitivity	Magnitude	Duration	Significance
Construction	Displacement	High	Low	Medium	Minor
Operation	Collision	Very High	Negligible	Long-term	Minor
	Displacement	High	Negligible	Long-term	Negligible
	Barrier	Medium	Negligible	Long-term	Negligible
Decommissioning	Displacement	High	Negligible	Medium	Negligible
Cumulative	All	Very High	Negligible	Long-term	Minor

4.37.5 Conclusions

Habitats Appraisal

Based on the distance the closest SPA for which puffin is a qualifying species is from the proposed development site and the broad distribution of puffins in Aberdeen Bay, there will not be an adverse effect on the SPA for which puffin is a qualifying species.

Environmental Impact Assessment

Based on the numbers and distribution of puffins in Aberdeen Bay and their predicted behaviour towards wind farms it is concluded that there will not be a significant environmental effect arising from the proposed development on puffins, although should displacement occur then there may be a minor impact.

5.0 OTHER SPECIES

The following bird species were recorded during the surveys undertaken within Aberdeen Bay, including radar studies and vantage point counts. The numbers recorded for the following species were either low or they are not qualifying species for any SPAs likely to be affected by the proposed development.

Further detailed assessment for these species has not been undertaken as either the numbers recorded were very low or, as was the case for most waders, the majority of records were of birds within very close proximity to shore or even, on occasions, overland. Consequently, the risk of an interaction with the proposed development is negligible.

5.1 Mute swan

Four mute swans were recorded during the vantage point surveys with three in April 2007 and one in December 2006 (AlbaEcology 2008a, EnviroCenter 2007b).

5.2 Brent goose

Twenty Brent geese were recorded off Murcar in September 2005 and a further 19 from visual observations undertaken at the same time as the Bird Detection Radar studies in October 2005. A further skein of five birds was recorded in during further radar studies in April 2007 (Walls *et al.* 2006, Simms *et al.* 2007).

5.3 Tufted duck

A pair of tufted duck were recorded flying north in April 2007 from boat-based surveys and 11 were recorded at Blackdog during the radar surveys undertaken in April 2007 (Simms *et al.* 2007).

5.4 Surf Scoter

A single drake surf scoter was recorded in flight from boat-based surveys in August 2011.

5.5 Black-throated diver

A single black-throated diver was recorded heading south past Blackdog in September 2006 it was recorded flying between, 0-30 m above sea level and between 1-2 km offshore (EnviroCentre 2007). A further black-throated diver was seen flying past Blackdog in January 2007 and two past Donmouth in February 2007 (EnviroCentre 2007). One black-throated diver was recorded at Blackdog during the April 2007 radar surveys (Simms *et al.* 2007).

5.6 Great northern Diver

One great northern diver was recorded from boat-based surveys in January 2011.

five great northern divers were recorded from vantage point surveys undertaken between April 2006 and March 2008. Singles were recorded in July, August, and December and two in September. All were recorded flying below 30 m (Alba Ecology 2008a, EnviroCenter 2007).

5.7 Sooty shearwater

A single sighting in November 2010 was the only record from boat-based surveys (SMRU 2011b). During vantage point surveys undertaken between April and October 2006 a total of 12 sooty shearwaters were recorded and a further 15 between April 2007 and November 2007 (EnviroCentre 2007, Alba Ecology 2008a,b). All sightings were of birds flying below 30 metres and predominantly more than 2 km from shore. One sooty shearwater was recorded flying north in October and one was recorded at Drums, during the radar studies in October 2005. (IECS 2008; Walls *et al*. 2006).

5.8 European Storm petrel

One record from vantage point surveys was of a single bird in October 2007 (Alba Ecology 2008b) and one was seen from boat-based surveys in June 2011.

5.9 Grey Heron

Singles at Murcar in August 2005, Drums in October 2005, Donmouth in June 2006 and Balmedie in August 2006 were the only records (EnviroCenter 2007). One was seen from boat-based surveys undertaken in August 2010.

5.10 Great-crested grebe

There was one record of a great-crested grebe from the vantage point surveys in October 2007 (Alba Ecology 2008b).

5.11 Sparrowhawk

One was recorded during radar surveys in April 2007 (Simms *et al.* 2007).

5.12 Kestrel

One kestrel was recorded at the Donmouth in March 2007(EnviroCenter 2007).

5.13 Buzzard

One was recorded during radar surveys undertaken in April 2007 (Simms *et al.* 2007).

5.14 Osprey

A single osprey was seen at the Donmouth in July 2007 (Alba Ecology 2008b).

5.15 Oystercatcher

Small numbers recorded from land based observations with maximum counts of 10 in August 2006 and 11 in April 2006 and 60 in February 2007, all at Drums and 43 at Blackdog in April 2007 (AlbaEcology 2008a,b; EnviroCenter 2007b).

5.16 Ringed plover

Fifteen ringed plover were recorded at Drums in October 2005.

5.17 Northern Lapwing

A total of 930 lapwing were recorded at Drums in October 2005.

5.18 Knot

Fifteen at Balmedie in August 2005 and Four in January at the Donmouth were the only records.

5.19 Sanderling

Small numbers of sanderling were regularly recorded along the beach of Aberdeen Bay. Peak totals were of 110 at Blackdog in April 2007, 49 at Easter Hatton in October 2005 and 12 at Blackdog during September 2006 (EnviroCenter 2007a, b, Simms *et al*. 2007).

5.20 Dunlin

Small numbers of dunlin were recorded during land-based counts with four at Drums and 11 at Blackdog in June 2006 and 30 February 2007 from Donmouth. Two dunlin were recorded from boat-based surveys both flying below 30 m.

5.21 Black-tailed godwit

Eighteen black-tailed godwits in April at Blackdog in 2007 was the only record.

5.22 Bar-tailed godwit

Six at Balmedie in April 2005, one at Drums in October 2005, one in September 2006 and two in April 2006 both at Blackdog were the only sightings.

5.23 Whimbrel

Singles at Drums in April 2005 June 2006 at Blackdog and Drums in April 2006 were the only records.

5.24 Curlew

Curlews were generally regularly recorded in small numbers of less than 40 birds throughout the year from land-based observations. One exception was of counts undertaken in October 2005 when 941 were recorded at Drums and 235 at Easter Hatton.

5.25 Redshank

Three sightings of redshank were all from Blackdog where there were 25 in April 2006, seven in June 2006 and 27 in April 2007. There were no other sightings of redshank from other land-based or boat-based surveys.

5.26 Turnstone

Three turnstone were recorded from land-based counts in October 2005.

5.27 Long-tailed skua

There was one record, in May, of an adult long-tailed skua flying north from boat-based surveys.

5.28 Pomarine skua

In Aberdeen Bay, Pomarine skuas were recorded in very small numbers between June and September with 2 in June and one in August. All records were of birds flying below 30 m. A further 12 Pomarine skuas were recorded during radar studies undertaken in October 2005. Six were at Drums and six at Easter Hatton (Walls *et al* 2005).

5.29 Glaucous gull

A total of seven glaucous gulls were recorded from the surveys. All were made during vantage point counts with a total of six records at Blackdog between November 2007 and March 2008 and one at the Donmouth in February 2008.

5.30 Little gull

In Aberdeen Bay little gulls are scarce with a total of twenty recorded between April and July 2006 with a peak count in May 2006 of up to 2 birds per hour (EnviroCentre 2007). There were no records of little gulls during 2007 surveys and only one record in March 2008.

There was one further record in August 2010 (SMRU 2011b).

Little gulls were recorded out to 3 km from shore and half of all sightings were of birds flying between 30-150 m.

One little gull was recorded at Easter Hatton during the radar studies in October 2005. (Walls *et al* 2005).

5.31 Sabine's gull

One was seen from Easter Hatton during radar studies in October 2005 (Walls *et al*. 2006).

5.32 Black guillemot

There were two records of black guillemot from vantage point surveys: four birds of Drums in November 2007 and one there in March 2008.

5.33 Little auk

The majority of records of little auk were from surveys undertaken in November 2007 when up to 194 little auks were recorded from land-based observations. Boat-based records were during October and November with a total of 12 birds seen. A further five were recorded in April 2007. All sightings were of birds in flight, flying below 15 m.

5.34 Woodpigeon

A single woodpigeon was seen in April 2007.

5.35 Swift

Two in June 2007 at the Donmouth.

5.36 Skylark

Two skylark were seen in April 2007.

5.37 Swallow

There were only a few sightings of swallows reported from land-based observations with a maximum 8 at Blackdog in April 2007 and ones or twos from other observation points during the summer months.

5.38 Sand martin

A single sand martin was recorded during April 2007 at Blackdog.

5.39 Meadow pipit

A single meadow pipit was recorded in March 2007 at the Donmouth.

5.40 Redstart

Two redstarts were recorded at Easter Hatton during October 2005.

5.41 Blackbird

A flock of 25 blackbirds were recorded from land-based observations undertaken at Drums during November 2007.

5.42 Redwing

A single redwing was recorded in October 2005.

5.43 Carrion Crow

Four carrion crows were recorded from land-based observations in April 2007. One at the Donmouth, two at Blackdog and one at Balmedie.

5.44 Linnet

Four linnets were recorded from land-based counts in April 2007.

5.45 Snow bunting

A flock of thirteen were recorded at Blackdog during November 2007.

6.0 SUMMARY

For the main species recorded from surveys undertaken within the proposed development area the results from the Impact Assessment presented in Section 4.0, are summarised in Table 6-1. The results presented do not take into account any specific mitigation measures that may be developed in the future that would further reduce the risks and remove or remedy any significant or adverse impacts that may arise (see Section 7.0).

The results of the assessment identified 36 species of bird that due to either their conservation status, i.e. are a qualifying species for an SPA or due to the numbers recorded within the proposed development area could be impacted by the proposed development.

Three potential impacts were identified: Collision, Displacement and Barrier effects. The potential for both direct and indirect disturbance has also been considered as part of the displacement assessment.

The significance of any potential impact arising from the construction, operation and decommissioning of the proposed development is assessed on the predicted sensitivity of the species to the potential impacts and the nature conservation value of the species concerned. An evidence based assessment has been undertaken to determine the overall significance of the potential impacts.

The results indicate that for most species the proposed development is only likely to have an effect of negligible significance or at worse an impact of minor significance and therefore not significant in terms of the EIA regulations.

The impact assessment has identified the potential for impacts of moderate significance on red-throated diver. This impact relates to the potential displacement effects caused by the presence of the wind turbines

Red-throated diver may be displaced from the area of the proposed development during construction, operation and decommissioning phases. Site specific data indicate that although the higher numbers of red-throated diver occur to the north of the proposed development area a proportion of the local regional population may be displaced. The effects of the possible displacement on red-throated divers are unknown but could be significant were all those displaced not to survive. However, this scenario is considered improbable as the proposed development is in an area not favoured by red-throated diver and any Divers that may be displaced will be able to move to other suitable foraging areas. Peak numbers of red-throated divers occur during the spring when they are moving north to their breeding grounds and therefore any displacement effects on individual migrating red-throated divers are relatively short term. Therefore, although the impact may be moderate in terms of displacement the actual impact on the Diver population within Aberdeen Bay is predicted to be negligible or minor.

All other impacts were assessed as being either negligible or minor and therefore not significant based on the species' sensitivities and predicted magnitude of the impacts.

Table 6-1: Summary of Impact Assessment.

Species	Impact			Significance of impact
	Collision Risk	Barrier	Displacement	
Whooper swan	Negligible	Negligible	Negligible	Not significant
Pink-footed goose	Minor	Negligible	Negligible	Not significant
Greylag goose	Minor	Negligible	Negligible	Not significant
Barnacle goose	Minor	Negligible	Negligible	Not significant
Shelduck	Minor	Negligible	Negligible	Not significant
Eurasian wigeon	Negligible	Negligible	Negligible	Not significant
Eurasian Teal	Negligible	Negligible	Negligible	Not significant
Mallard	Minor	Negligible	Negligible	Not significant
Common eider	Minor	Minor	Minor	Not significant
Long-tailed duck	Negligible	Negligible	Minor	Not significant
Common scoter	Negligible	Negligible	Minor	Not significant
Velvet scoter	Negligible	Negligible	Minor	Not significant
Goldeneye	Negligible	Negligible	Minor	Not significant
Red-Breasted Merganser	Negligible	Negligible	Negligible	Not significant
Red-throated diver	Negligible	Minor	Moderate	Not significant
Fulmar	Minor	Negligible	Negligible	Not significant
Manx shearwater	Negligible	Negligible	Negligible	Not significant
Northern gannet	Minor	Negligible	Negligible	Not significant
Great cormorant	Minor	Negligible	Minor	Not significant
European shag	Minor	Negligible	Minor	Not significant
Arctic skua	Negligible	Negligible	Negligible	Not significant
Great skua	Negligible	Negligible	Negligible	Not significant
Golden plover	Negligible	Negligible	Negligible	Not significant
Kittiwake	Minor	Negligible	Negligible	Not significant
Black-headed gull	Negligible	Negligible	Negligible	Not significant
Common gull	Minor	Negligible	Negligible	Not significant
Herring gull	Minor	Negligible	Negligible	Not significant
Lsr black-backed gull	Minor	Negligible	Negligible	Not significant
Grt black-backed gull	Negligible	Negligible	Negligible	Not significant
Little tern	Minor	Negligible	Minor	Not significant
Sandwich tern	Minor	Negligible	Minor	Not significant
Common tern	Minor	Minor	Minor	Not significant
Arctic tern	Minor	Negligible	Minor	Not significant
Guillemot	Minor	Negligible	Minor	Not significant
Razorbill	Minor	Negligible	Minor	Not significant
Atlantic puffin	Minor	Negligible	Minor	Not significant

7.0 MITIGATION AND MONITORING

Detailed mitigation and monitoring measures aimed to avoid, remove or reduce any potentially significant impacts will be developed more fully during consultation with the Regulator and their statutory advisors and other stakeholders.

The main potential impacts arising from the proposed development relate primarily to direct or indirect displacement effects on Divers and to a lesser extent Terns. Mitigation that may be considered as measures to help avoid, remove or reduce potential impacts include:

Minimising the proposed development area: By reducing as far as practicable the overall area of the proposed development, the total area and consequently the total number of red-throated divers that may be displaced will be minimised. A number of factors need to be taken into consideration when identifying the location of turbines, including the minimum distance turbines may be able to operate effectively. The current lay out is based on the minimum practical distance possible between turbines, taking into account the physical properties of the likely turbines, features of the seabed, water depth, other sea users as well as comments received during the consultations undertaken during the development of this project. Subject to further consultation, it is currently predicted that there will not be any significant change in the positions of the currently planned wind turbine locations, which covers an area of 4.3 km^2.

Vessel management plans: The potential disturbance of seaduck and Divers and other seabirds from the proposed development area by construction, maintenance or decommissioning vessels may be reduced by minimising the number vessels used during any of phases of the proposed project. Furthermore, ensuring that all vessels use the existing shipping lanes within Aberdeen Bay for as much time as possible will minimise the number of birds potentially displaced. Further discussions with the relevant authorities will help identify potential suitable traffic routes.

Foundation types: The use of monopiles as a type of foundation requires the use pile-driving to install them, which may cause an effect on prey species and consequently impact on predators. By selecting alternative foundation types, e.g. gravity based structures or jackets that require smaller piles, there is the potential to reduce the risk of an impact on the prey species and therefore reduce the possibility of a displacement effect being caused by construction activities. Further consideration of the foundation types will be made following geotechnical surveys. Means to minimise the potential effects of noise generated by pile-driving, should it occur, would be considered in line with the latest relevant guidance and would for example include 'soft-start'.

Timing and duration of installation: The timing and duration of installation have still to be determined. Site-specific data indicate that there are birds present in Aberdeen Bay throughout the year with peak numbers occurring at different times of year depending on the species. Therefore, it may not be possible to select a period for construction activities to take place at a specific time of year that has relatively lower bird numbers present and therefore less sensitive. It is also recognised that there may be other environmental and project aspects, e.g. fish spawning periods or vessel availability that will need to be considered when identifying potential development construction periods. The timing of possible construction would be further considered during the consenting process when details on the potential project schedule are developed.

Minimising aviation and navigation lighting: Birds can be attracted to bright lights, e.g. lighthouses, particularly during poor weather conditions. In order to reduce the risk of birds being attracted to the proposed development all lighting will be kept as far as practicable to a minimum but still kept within the requirements to ensure safety. Discussions with the relevant authorities on minimum lighting requirements to ensure safety would be held.

It is essential that any monitoring undertaken is designed to address specific concerns or potential impacts identified during the EIA process. Poorly designed *ad hoc* monitoring is likely to be inefficient and not provide useful or meaningful results. It is therefore important that any monitoring programme is developed in collaboration with the Regulator and statutory advisors and takes note of key stakeholders comments arising from the consultation period.

A detailed monitoring programme aimed at specific issues or concerns are to be developed with the Regulator and advisors should consent be granted.

The proposed EOWDC aims to encourage and enable environmental monitoring through research and development. The research and monitoring will seek to answer outstanding questions on environmental impacts from offshore wind, including those on birds.

In order to facilitate the delivery of research a steering group will be formed and managed by an R&D manager. Specialist working groups will provide the detailed technical competences supporting the R&D.

Future research and monitoring will be agreed through the R&D working group but potential monitoring and research includes:

- Collision risk studies on birds;
- Tagging and tracking studies of seabirds to and from breeding colonies and outwith the breeding season to look at barrier effects;
- Specific studies aimed at determining potential changes in bird distribution, i.e. displacement or attractant effects;
- Studies looking at potential secondary impacts on prey species, e.g. changes in prey fish and benthic distributions.

Further discussions will help develop these and other ideas into meaningful projects from which useful results will be obtained.

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8.0 APPENDIX A – COLLISION RISK MODELLING

8.1 Method

The collision risk assessment has followed the Band (2011) guidance and the Strategic Ornithological Support Services (SOSS) worked examples. The collision risk assessment is a six stage process outlined below. The approach taken for each of the six stages will be detailed below.

Stage A – Flight activity

Stage B- Estimating number of bird flights through rotor

Stage C – Probability of collision for a single rotor transit

Stage D – Multiplying to yield expected collisions per year

Stage E – Avoidance and attraction

Stage F – Expressing uncertainty

The collision risk assessment has been completed for the following seventeen species:

1. Guillemot
2. Razorbill
3. Puffin
4. Fulmar
5. Common tern
6. Sandwich tern
7. Herring gull
8. Black-legged kittiwake
9. Great black-backed gull
10. Common gull
11. Common scoter
12. Eider
13. Shag
14. Cormorant
15. Northern Gannet
16. Red throated diver
17. Arctic Skua

8.1.1 Stage A: Flight Activity

Collision risk assessment requires an estimation of the monthly density of birds in flight. This is derived from the snapshot counts of birds flying in the monthly boat based surveys.

Boat based bird surveys were undertaken as described in Section 0 The first phase (Phase 1) of boat based surveys was carried out in February 2007-April 2008 and consisted of 15 surveys. The second phase (Phase 2) was carried out August 2010-January 2012, and consisted of 15 surveys. The survey areas covered and transect design for Phase 1 and Phase 2 differ, as shown in Figure 8-1 and Figure 8-1: Phase 1 survey area consisting of 'Control' and 'Treatment area', all the survey area (outlined with the brown box) was used to estimate bird densities in flight.

Phase 1 covered a total survey area of 101.6 km2, with the total transect length being 148 km. Originally the Phase 1 survey areas separated into a 'control area' and a 'treatment area' containing the turbines, however it is recognised that the separation true controls with similar environmental conditions are difficult to achieve given far ranging impacts that could extend into the control survey area. For the purposes of estimating flight activity both survey areas in Phase 1 have been used as this encompasses the majority of Aberdeen bay.

Phase 2 adopted a different transect design as illustrated in Figure 8-1: Phase 1 survey area consisting of 'Control' and 'Treatment area', all the survey area (outlined with the brown box) was used to estimate bird densities in flight.

The survey area was extended to the north, south and also included an offshore component. The total survey area was 338.8 km2 this is divided amongst the north (150.8 km2), south (82.8 km2) and offshore (105.2 km2) survey areas. The transect design changed as a result of an alternation in the proposed turbine layout. Another reason for the change is the increased survey area is expected to improve the monitoring of potentially far field impacts.

For the purposes of estimating bird density all the data collected during Phase 1 will be used, whereas only the North area has been used in the Phase 2 surveys. The majority of bird observations were recorded in the North transect.

Both phases of survey followed the same line transect survey methodology. Linear transects were collected with snapshots of birds collected within a 300 m x 300 m 'box' to the side of the vessel with the best viewing conditions. The total area captured within each snapshot = 0.09 km2. The total number of birds observed in flight within these snapshots was then divided by the total snapshot area to yield the aerial density of birds in flight. In addition, observations of birds in flight were collected and these were recorded as off effort if they were collected at a distance of 300 m from the vessel or were recorded opportunistically during surveys.

The total number of snapshots conducted in each of the 15 surveys in phase 1 was 493, the total area of captured in snapshots was 44.37 km2. The survey effort in the 15 surveys carried out in phase 2 was more variable and a range of 230-255 snapshots were collected per survey, the total area captured in the snapshots ranged from 20.7-22.95 km2 per survey (Appendix B).

The guidance on collision risk assessments recommends using density estimates from the development site. However, the EOWDC crown estate lease area is a relatively small area being only 20 km2. With snapshots collected every 300 m this would result in only a limited number of counts being collected in the development area. Deriving estimates from a small number of monthly counts (and small snapshot area) may lead to a misrepresentation of densities of birds flying in the development area. The approach taken in this assessment was to derive bird density estimates from Phase 1 and Phase 2 boat based survey (north area only).

For each month a mean density and standard deviation were calculated from all surveys undertaken within that month. The collision risk model evaluates risk on a month by month basis across the year in order to reflect changing bird abundance within the study area.

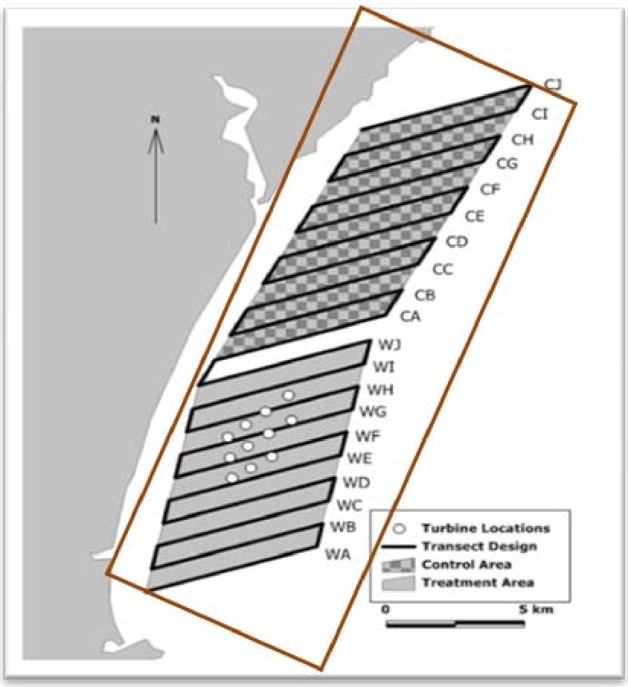

Figure 8-1: Phase 1 survey area consisting of 'Control' and 'Treatment area', all the survey area (outlined with the brown box) was used to estimate bird densities in flight.

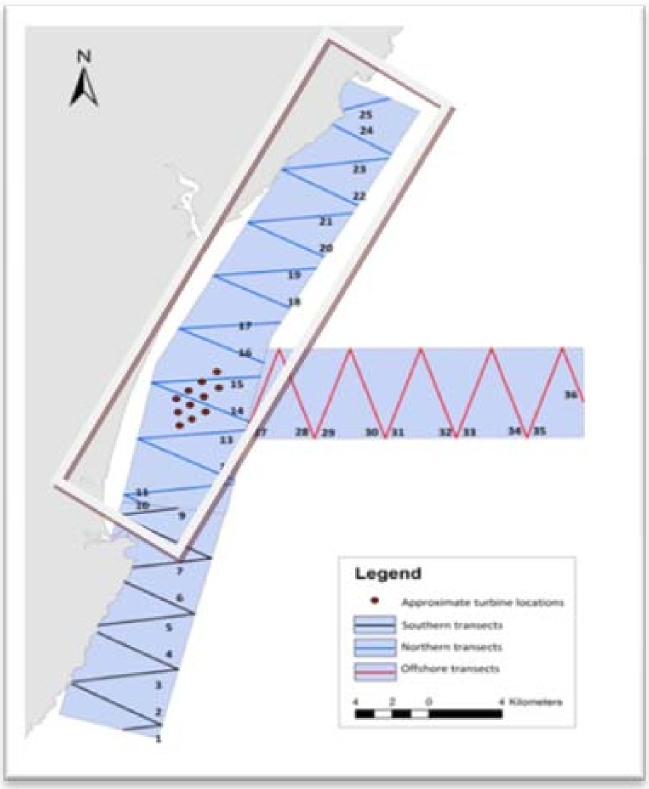

Figure 8-2: Phase 2 survey area consisting of three areas (North, South and Offshore), only the North transect (outlined with the brown box) was used to estimate bird densities in flight.

The distribution of the monthly boat based surveys in Phase 1 and Phase 2 are given in Table 8-1. A number of surveys were missed due to poor survey conditions, when possible duplicate surveys occurred in the next available survey month. May and December are the only months with less than 2 surveys, with 6 months having over 3 surveys Table 8-2 .

Table 8-1: Monthly boat based surveys conducted for the European Offshore Wind Deployment Centre (EOWDC), blue illustrates successful survey, April 2008, June and July 2011 have two surveys.

		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Phase 1 n=15	2007	-											
	2008			-	x 2	-	-	-	-	-	-	-	-
Phase 2 n= 15	2010	-	-	-	-	-	-	-			-		-
	2011					-	x 2	x 2		-			-
	2012		On-going surveys not used in analysis										

Table 8-2: Total number of EOWDC surveys per month collected 2007-2011.

Month	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Total number of surveys	3	3	2	4	1	3	3	3	2	2	2	1

Proportion flying at collision height

The boat based surveys recorded the flight heights of birds using bands of 0 - 2 m, 2 - 10 m, 10 - 25 m, 25 - 50 m, 50 - 100 m, 100 - 200 m and 200 +m. The observations of birds in flight heights were collected during snapshot counts, and also from observations of birds captured when off transect.

The proportion of birds flying at collision height was calculated by the proportion of birds identified as flying within the 25 - 200m.

The results of the number of birds recorded flying at the various height bands and also the proportion flying at risk height recorded from Phase 1 and Phase 2 surveys is given in Table 8-16. The observations of flying birds were taken from all surveys areas for both Phases of boat based surveys.

Nocturnal activity factor

The collision risk assessment takes into consideration the amount of daylight and hours of darkness that birds are expected to be active. Bird species were assigned a nocturnal activity factor this is a six point scoring system between 1-5 designed by Garthe and Hüppop (2004). For example Gannet was assigned a nocturnal activity factor of 2, which translates to approximately 25% activity in comparison to daytime levels. No surveys occurred during hours of darkness at the EOWDC so it was not possible to use site specific data.

EOWDC latitude

The windfarm latitude in decimal degrees is 57o 1' North. This is inputted in the collision risk model to determine the amount of daylight and night time hours, these are used further within the calculations of nocturnal activity and bird density.

Stage A Flight activity example of input parameters into collision risk model

A worked example of Stage A data input parameters into the collision risk model is provided using Gannet as an example.

Table 8-3: Northern Gannet flight densities derived from Phase 1 and Phase 2 surveys

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Mean density birds/km^2	0.00	0.02	0.00	0.03	0.07	0.34	0.33	0.39	0.29	1.11	0.03	0.00

Proportion flying at risk height	8.55%	Derived from Table 8-16
Nocturnal activity factor	2	Garthe and Hüppop (2004)
Windfarm latitude	57^{o} 1'	EOWDC Latitude

Stage A output parameters

The Stage A output parameters are given in Table 8-4, these are provide the total daylight, night hours and total hours per month, the example provided is for the Gannet.

Table 8-4 Stage A output parameters for the Gannet

			Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Daytime areal bird density	birds/sq km		0	0.0 2	0	0.0 3	0.0 7	0.3 4	0.3 3	0.3 9	0.2 9	1.1 1	0.0 3	0
Proportion at rotor height	%	**8.6%**												
Total daylight hours per month	hrs		231	264	365	427	511	534	534	472	386	323	245	212
Total night hours per month	hrs		513	408	379	293	233	186	210	272	334	421	475	532
Total hours per month	hrs		744	672	744	720	744	720	744	744	720	744	720	744

8.2 Stage B: Estimating number of flights through rotors

Stage B will estimate the number of flights through the turbines by a using the Stage A calculations with the design parameters of the EOWDC and also the flight characteristics of the bird species investigated. Input parameters required for Stage B are EOWDC windfarm data and flight speed of bird species.

Windfarm Data

The EOWDC will consist of 11 turbines installed within the Crown Estate lease area. The turbine parameters used within the collision risk model apply to a number of commercially available turbines that fall within parameters defined in the Rochdale envelope. At this stage in the design of the EOWDC it is expected that no turbines greater than 7MW are likely to be installed. A 7MW turbine has been assessed in the collision risk model, with many of the parameters being derived from the upper limits (worst case) supplied within the Rochdale envelope.

The potential number of flights through the rotors depends on a number of factors including the rotor size and the rotors elevation from the sea surface. The rotor radii are 75 m, with a sea clearance of no less than 25 m. Where possible the parameters are based on the upper limits of the realistic criteria, for example the mean revolutions per minute of a number of commercially available turbines was within a range of 7.1-7.4 rpm, and the factor applied in the model was 7.4rpm. The parameters used for the 11 turbines are outlined in Table 8-5.

Table 8-5: Turbine parameters applied in the collision risk model.

7MW turbines	Value	Comments
Rotor diameter	150 m	Expected to be <150 m
Mean revolutions per minute (rpm)	7.4 rpm	Derived from indicative wind profiles and wind cut out points as per SOSS methodology
Sea clearance rotor tip to sea level	>25 m	-
Max rotor diameter	6.5 m	-
Pitch	30 degrees	Expected to be <30 degrees
Monthly operating time	85%	Further work is currently on-going to better parameterize this. 85% used as a mean average.

Stage B Input parameters

The input parameters for stage B are given in Table 8-6. Flight speeds for the bird species assessed were taken from Pennycuick (1987) and Alerstam, 2007, or were derived from a similar species.

Table 8-6: Input parameters for Stage B, windfarm data and bird data (example shown is for the Gannet)

Windfarm data		
Number of turbines	11	
Rotor radius	75	
Bird data		
Gannet flight speed	14.9 m/sec	(Pennycuick 1987)

Output of Stage B

The output of Stage B determines the potential number of bird transits though the rotors, per month and per annum. Shown in Table 8-7 are the number of rotor transits of gannet through the EOWDC turbines, per month and per annum (6,380 birds/annum). Note that the operational time of the EOWDC turbines has yet to be factored in at this stage in the calculation.

Table 8-7: Stage B rotor transits for the Gannet per month

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum
Potential bird transits through rotors	0	31	0	76	213	1078	1047	1095	665	2131	44	0	**6,380**

8.3 Stage C: Probability of collision for a single rotor transit

Stage C assess the likelihood of a collision of a bird with a turbine for a single rotor transit. The calculation uses the characteristics of the bird (body size, wing span, flight speed) against the turbine data.

Bird data

The bird data applied in the collision risk model has been derived from a number of sources and is summarised for the species assessed in Table 8-8. British Trust for Ornithology (BTO) bird fact sheets were used to determine values for the body length and wing length. Bird flight speed and nocturnal activity factors are described in Section 0.

The collision risk takes into consideration the flight characteristics of the bird, specifically whether the flight is of a flapping or gliding motion. Flapping flight increases the surface area available for a turbine strike. An example is the Gannet, which uses a mixture of flapping and gliding, in the collision risk model this bird has been assessed as flapping which is a more precautionary basis.

Proportion flying at risk height

The proportion of birds flying at risk height has been determined from two sources, EOWDC boat based survey data and also from a review of bird flight height data compiled by Cook et al., (2011). The collision risk assessment has used applied both site specific data collected during the EOWDC surveys, and has also used re-run the assessment using generic flight height data. There were broad similarities in the values produced for the proportion flying at risk height using EOWDC data and the Cook et al., (2011) review.

Proportion flying at risk height EOWDC survey data

The approach taken to determine the proportion of birds flying at risk height derived from EOWDC boat based surveys is described in Section 0. The results are summarised in Table 8-8 and presented further in Section 8.9. The number of samples used to determine the proportion at risk height was n>100 with the exception of eider, cormorant, great skua and Arctic skua. It was considered species with less than 100 observations recorded may not be a representative size to categorise the proportion flying at risk height, and in such cases it the Cook et al., (2011) proportion at risk height determined may provide a better representation of flight heights.

PROPORTION FLYING AT RISK HEIGHT COOK *ET AL*., (2011) REVIEW

An extensive review of flight height information of birds has been completed by Cook et al. (2011). This report determined the proportion of birds that were flying at risk height from the analysis of windfarm bird survey data. In total, data from 38 surveys of 31 existing, proposed or consented offshore wind farms were used in the Cook et al., (2011) review.

The proportion flying at risk height has been assessed on the basis of a turbine with rotor blades a minimum of 20 m above sea-level with a diameter of 130 m. The turbine parameters differ to that used in the EOWDC, the result is that this will capture a higher proportion of birds flying at risk height.

Table 8-8 Summary of seabird characteristics used within the collision risk model

Bird species	Bird length (m)	Wingspan (m)	Flight speed m/s	Nocturnal activity Factor 1-5 (Garthe and Huppop 2004)	Flight type (flapping/ gliding)	Proportion at risk height, EOWDC % (Table 8-16)	Proportion at risk height (Cook *et al*, 2011)
	(BTO bird fact sheets, 2011)						
Red throated Diver	0.61	1.11	18.6 (Alerstam, 2007)	1	Flapping	4.71	3.21
Gannet	0.94	1.72	14.9 (Pennycuick 1987)	2	Flapping	8.55	15.77
Common gull	0.41	1.20	13.4 (Alerstam, 2007)	3	Flapping	30.75	22.69
Black legged Kittiwake	0.39	1.08	13.1 (Pennycuick 1987)	3	Flapping	18.56	16.05
Herring gull	0.60	1.44	11.3 (Pennycuick 1987)	3	Flapping	31.75	30.59
Guillemot	0.40	0.70	19.1 (Pennycuick 1987)	2	Flapping	0.61	4.14
Razorbill	0.38	0.66	16.0 (Pennycuick 1987)	1	Flapping	0.15	6.77
Puffin	0.28	0.55	17.6 (Pennycuick 1987)	1	Flapping	0.00	0.02
Fulmar	0.48	1.07	13.0 (Pennycuick 1987)	4	Gliding	0.65	4.88
Shag	0.72	0.98	15.4 (Pennycuick 1987)	1 (used the Cormorant)	Flapping	0	13.11
Arctic Skua	0.44	1.88	13.3 (Pennycuick 1987)	1	Flapping	16.07[2]	3.30
Great Skua	0.56	1.36	14.9 (Pennycuick 1987)	1	Flapping	13.3[2]	6.53
Great black-backed gull	0.71	1.58	12.4 (Pennycuick 1987)	3	Flapping	41.46	35.05
Common tern	0.33	0.88	10.9 (used Arctic Tern)	1	Flapping	2.77	8.26
Sandwich tern	0.38	1.00	13.33 (Bird life international 2012)	1	Flapping	5.77	7.10
Arctic tern	0.34	0.80	10.9 (Alerstam, 2007)	1	Flapping	7.28	4.41
Eider	0.60	0.94	17.9 (Alerstam, 2007)	3	Flapping	1.02[2]	2.03
Common Scoter	0.49	0.84	22.1 (Alerstam, 2007)	3	Flapping	2.60	4.39
Cormorant[1]	0.90	1.45	15.2 (Alerstam, 2007)	1	Flapping	1.88[2]	N/A[1]

1. Flight heights of Cormorants were found to be highly variable in offshore areas, models generated by Cook *et al*., (2011) of flight heights of cormorants recorded in offshore surveys were unable to produce a mean estimate. Previous investigations of cormorant flight heights estimated a relatively low mean height of 8.3 m (range 1 – 150 m) within a relatively wide range (Walls *et al.* 2004; Parnell *et al.* 2005; Petersen *et al.* 2005). 2. Denotes that <100 observations of birds in flight were used to determine proportion at risk.

Stage C: Probability of single collision risk data inputs parameters

The information inputted into the collision risk spreadsheet to in Stage C to assess the probability of a single collision risk is provided in Table 8-9 and Table 8-10.

Table 8-9: Bird data inputted into collision risk spreadsheet (example Gannet)

Bird data	
Bird Length	0.94m
Wingspan	1.72m
Flight speed	14.9 m/sec
Flight style	Flapping
Proportion of flights upwind	50%

Table 8-10: Turbine parameters inputted into collision risk spreadsheet

Turbine data	
Number of blades	3
Rotor radius	75 m
Maximum blade width	6.5 m
Average pitch	30^{o}
Rotation speed	7.4 rpm

Stage C output

The output is a calculation of the risk of collision of a bird during a single transit through a turbine. The result is expressed as a percentage risk for upwind and downwind. The average of the risk for upwind and downwind is used for the 'overall collision risk', this is expressed as a percentage. The risk of a collision during a single transit of a Gannet through a turbine in the EOWDC is given in Figure 8-3. The upwind collision is 11.8%, downwind collision is 5.0% with the overall collision being 8.4%.

			Calculation of alpha and p(collision) as a function of radius							
NoBlades	3					Upwind:			Downwind:	
MaxChord	6.50	m	r/R	c/C	α	collide			collide	
Pitch (degrees)	30		radius	chord	alpha	length	p(collision)		length	p(collision)
Species name	Gannet		0.00				1.00			1.00
BirdLength	0.94	m	0.05	0.73	5.13	32.26	0.80		27.52	0.68
Wingspan	1.72	m	0.10	0.79	2.56	18.38	0.46		13.24	0.33
F: flapping (0) or gliding (+1)	0		0.15	0.88	1.71	14.27	0.35		8.55	0.21
Proportion of flights upwind	50%	%	0.20	0.96	1.28	12.25	0.30		6.01	0.15
Bird speed	14.9	m/sec	0.25	1.00	1.03	10.79	0.27		4.29	0.11
Rotor Radius	75	m	0.30	0.98	0.85	9.37	0.23		3.00	0.07
Rotation Speed	7.4	rpm	0.35	0.92	0.73	8.04	0.20		2.06	0.05
Rotation Period	8.11	sec	0.40	0.85	0.64	6.93	0.17		1.41	0.03
			0.45	0.80	0.57	6.15	0.15		1.01	0.03
			0.50	0.75	0.51	5.54	0.14		1.21	0.03
Bird aspect ratio: β	0.55		0.55	0.70	0.47	5.05	0.13		1.38	0.03
			0.60	0.64	0.43	4.56	0.11		1.48	0.04
Integration interval	0.05		0.65	0.58	0.39	4.11	0.10		1.54	0.04
			0.70	0.52	0.37	3.70	0.09		1.56	0.04
			0.75	0.47	0.34	3.37	0.08		1.56	0.04
			0.80	0.41	0.32	3.01	0.07		1.53	0.04
			0.85	0.37	0.30	2.77	0.07		1.51	0.04
			0.90	0.30	0.28	2.40	0.06		1.43	0.04
			0.95	0.24	0.27	2.08	0.05		1.36	0.03
			1.00	0.00	0.26	0.94	0.02		0.94	0.02
			Overall p(collision) integrated over disk							
						Upwind	11.8%		Downwind	5.0%
		Proportion	upwind: downwind							
			50%	50%			Average	8.4%	(copied to sheet 1)	

Figure 8-3: Example of the calculation of collision during a single transit through a turbine for the Gannet.

8.4 Stage D: Multiplying to yield expected collisions per year

In this stage the output from Stage B (number of potential transits through rotors) is multiplied by the output of Stage C (collision risk for a single rotor transit). This calculates the projected number of bird collisions per month/year. The collision risk model can make allowance for the proportion of time the turbines are operational. The proportion of time operational depends upon the wind strength and any non-operational time as a result of maintenance. It has not been possible to derive monthly operational figures for the EOWDC turbines. For the purposes of the collision risk assessment a monthly operational time of 85 % has been applied which is in line with industry figures, although it is recognised having a fixed value per month may not reflect better wind speeds in winter, or the increase in maintenance that is typically associated with better weather in the summer months.

Refinement of the proportion of time turbines are operational is possible once the wind frequency distribution at the site is available and assessed against the operating parameters of the turbines to be installed. At this stage a fixed figure of 85% will be used, the proportion of time operational is factored into the error estimate in the collision risk model, discussed further in Section 8.6.

Large array correction factor

A large array correction factor is applied within the collision risk calculation and is used to take into account the change in densities of birds as a result of the removal of animals from collisions as they pass through the array. This calculation is more applicable to large turbine arrays with multiple rows and less so for small arrays like the EOWDC with only 11 turbines arranged into 2 rows.

COLLISION RISK ASSESSMENT
Sheet 5 - Large array correction factor

Do not enter data on this sheet, unless to prescribe the number of turbine rows
All the data below is derived from Sheets 1, 2 or 3

Number of turbines	11		Number of rows (optional)			data from Sheet 1
Rotor radius	75		*(if this is left blank, number is assumed to be sqrt(T))*			data from Sheet 2
Width of windfarm	2.75		Number of turbines in each row			data from Sheet 3
Average proportion of time operational	0.85					data to be entered here (optional)
Collision risk from single rotor transit	0.084					calculated fields
Assumed number of turbine rows	3.3					
Avoidance rate	95.00%	98.00%	99.00%	99.50%		
Collision risk for single bird passage, before correction	0.00167	0.00067	0.00033	0.00017		
Large array correction factor	**99.94%**	**99.98%**	**99.99%**	**99.99%**		

Figure 8-4: Example output of a large array correction factor

The application of the large array correction was applied for all species studied and did not change the number of collisions for any of the birds assessed. In all cases the large array factor was >99.94% for the most conservative avoidance factor of 95%. An adjustment of the number of collisions by up to 0.06% is of minor significance to the outputs, especially given the greater influence of some of the other parameters applied within the model such as avoidance rate.

Stage d: Output

Stage D calculations are given Table 8-11; this is the number of bird collisions (assuming no avoidance) and accounts for non-operational time (85% per month) the example provided is the gannet.

Table 8-11: Output from Stage D: the number of bird collisions (assuming no avoidance) and accounting for non-operational time, (example shown is for the Gannet).

Stage D - multiplying up for entire windfarm and allowing for non-operational time	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Collisions assuming no avoidance birds per month or year	0	3	0	6	17	83	82	89	57	201	5	0	**543**

8.5 Stage E: Avoidance and attraction

The avoidance rate applied within the model is one of the key variables that determine the number of theoretical collisions. The evidence for species-specific avoidance rates to apply in collision risk assessments is incomplete, or absent for the majority of bird species. Collision risks have been calculated for avoidance rates of 95%, 98%, 99% and 99.5%, the collision risk considered to be the most appropriate will be detailed within the bird impact assessment for each species assessed.

The evidence for the windfarm attracting birds like avoidance rates is incomplete, windfarm that attract birds could result in a higher density of animals to be present within the area which would be at risk of future collisions. The evidence for turbines attracting birds will be discussed in the bird impact assessment.

The results of the Collision risk assessment are summarised as follows (using the Gannet as an example). At this stage of the output the uncertainty in the collision risk estimate has yet to be factored in.

Table 8-12: Outputs using SPSS Collision risk spreadsheet, using Gannet as an example.

Stage B	Potential annual bird transits through rotors	7643
Stage C	Risk for a single transit	8.4
	Collisions allowing for non operational time:	
Stage D	Assuming no avoidance	543
Stage E	95%	27
	98%	11
	99%	5
	99.5%	3

8.6 Stage F: Expressing Uncertainty

There are uncertainties in the input data and at several stages in the calculation, and these must be combined to given an understanding of the uncertainty and hence the likely accuracy of the estimated collision risk. The potential number of bird transits through rotors is a product of: Bird density x number of hours active x proportion flying at risk height x total area of rotors x proportion of time operational

And the total collision risk = potential number of transits x risk during a single transit.

Therefore the errors in each of these elements must be combined to estimate the total error or uncertainty. Each error or uncertainty (e1 – e5) is first expressed as a relative error, i.e. expressed as a fraction or percentage of the value to which it refers.

All the errors are seeking 95% certainty. Thus the range of uncertainty in bird density is taken as two standard deviations from the mean, and the assessment of the accuracy of the flight height observations is based on an expectation that flight height will have been categorised correctly in 95% of cases.

The errors (e) are assessed as follows:

Bird density (e1)

Bird density survey measurements showed variability between surveys and Phases. In Table 8-13 the Fulmar monthly flight densities, mean and standard deviations are given. To calculate the error in the collision estimates for a full year, this is the sum of the collision estimates for each of the twelve months. The annual collision rate depends approximately on the sum of the bird densities for each month. The standard deviation for the sum is obtained by summing the standard deviations, and taking the square root of the sum of squares, to allow for the act that errors in one month may be offset by errors in the other direction in other months. A complication with the EOWDC dataset is that there are 2 months (May and December) that only have 1 survey and it has not been possible to generate a standard deviation for such months. These two months have been removed from the following calculation using monthly standard deviations.

Sum of monthly bird densities = $Mean_{Jan} + Mean_{Feb} + Mean_{March} + Mean_{April} + Mean_{June} + Mean_{Jul} + Mean_{Aug} + Mean_{Sep} + Mean_{Oct} + Mean_{Nov}$

$SD_{year} = \sqrt{(SD_{Jan}^2 + SD_{Feb}^2 + SD_{Mar}^2 + SD_{Apr}^2 + SD_{Jun}^2 + SD_{Jul}^2 + SD_{Aug}^2 + SD_{Sep}^2 + SD_{Oct}^2 + SD_{Nov}^2}$

The relative error is: $\frac{1.96\ x\ SD_{Year}}{Sum\ of\ monthly\ bird\ densities}$

For the Fulmar example (mean and standard deviations given in Table 8-13) this is $e_1 = 0.70$. The majority of species assessed had relative errors that were >1.0 (greater than 100%), this is due to the high standard deviations in the monthly survey data.

Table 8-13: Fulmar Phase 1 and Phase 2 flight densities mean and standard deviation

		January	February	March	April	May	June	July	August	Septemb er	October	Novembe r	Decembe r
Phase 1	2007	-	0.18	0.02	0.02	0.11	0.14	0.05	0.02	0.02	0	0	0.09
	2008 survey 1	0.07	0.02	-	0.14	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.16	-	-	-	-	-	-	-	-
Phase 2	2010	-	-	-	-	-	-	-	-	0.35	-	0.13	-
	2011 survey 1	0.05	0.00	0.00	0.00	-	0.22	0.18	0.19	-	-		-
	2011 survey 2	-	-	-	-	-	0.04	0.14	0.14	-	0.00	0.14	-
	2012	0.09	-	-	-	-	-	-	-	-	-	-	-
Mean		0.07	0.07	0.01	0.08	0.11	0.14	0.12	0.12	0.18	0.00	0.09	0.09
Standard deviation		0.02	0.10	0.01	0.08	-	0.09	0.07	0.09	0.23	0.00	0.08	-

Nocturnal activity (e_2)

Nocturnal activity factors range from 0% (for the majority of birds) to 75% for the Fulmar, the most nocturnally active bird. There is considerable uncertainty in the use of nocturnal activity factors. In the absence of night-time survey data, it is estimated that an uncertainty of +/-10% may be appropriate to apply, the e_2=0.10.

Proportion at risk height (e_3)

The most significant error in relation to flight height is the classification of birds into flight height bands. The observers were all fully trained and checked accuracy of snapshot height estimates periodically, it is possible that some birds may have been classified incorrectly. If the visual estimate were out by +/- 5 m it is estimated that the proportion of birds flying would vary by around +/-25%, the e_3 = 0.25.

Turbine size and time operational (e_4)

It is assumed that the calculation of the turbine dimensions is reasonably accurate. The time operational has been assessed as being 85% each month. 75% may be a more realistic figure in summer months, and 95% in winter when the winds are stronger. Therefore an uncertainty of +/-10% may be appropriate, e_4 = 0.10.

Collision model errors (e_5)

The collision risk model involves a number of simplifications. SOSS (2011) assess an uncertainty of +/-20%, e_5=0.20.

Combining errors

The errors arise independently and so in combining errors it is appropriate to take a root mean square approach, to allow for the likelihood that some errors will offset others.

$E = \sqrt{(e_1^2 + e_2^2 + e_3^2 + e_4^2 + e_5^2)}$

The relative errors produced for the bird species assessed have been applied to the collision risk assessment outputs and have been presented in Table 8-103.

8.7 Results

8.8 Flight height distribution from snapshot counts in Phase 1 and Phase 2 surveys.

Snapshot counts were used to derive density of birds in flight that were recorded in transect, summary flight height distribution has been presented for birds recorded in Phase 1 (Table 8-16) and Phase 2 surveys.

The flight information derived from snapshot counts have been presented for the following species:

Species Name	Flight densities derived from EOWDC surveys		Collision risk estimate produced applying proportion of birds at collision height	
	Phase 1	Phase 2	EOWDC surveys flight data (Table X)	Cook *et al*., flight height data
Guillemot	✓	✓	✓	✓
Razorbill	✓	✓	✓	✓
Puffin	✓	✓	✓	✓
Fulmar	✓	✓	✓	✓
Common tern	✓	✓	✓	✓
Sandwich tern	✓	✓	✓	✓
Arctic tern	x	✓	x	x
Herring gull	✓	✓	✓	✓
Black-legged kittiwake	✓	✓	✓	✓
Great black-backed gull	✓	✓	✓	✓
Common gull,	✓	✓	✓	✓
Common scoter	✓	✓	✓	✓
Eider	✓	✓	✓	✓
Shag	✓	✓	✓	✓
Cormorant	✓	✓	✓	✓
Northern Gannet	✓	✓	✓	✓
Red throated diver	✓	✓	✓	✓
Arctic Skua	✓	✓	✓	✓
Great Skua	x	✓	x	x

Table 8-14: Summary of snapshot counts Phase 1 of survey data February 2007-April 2008.

Bird species	Flight Height bands							
	0-2 m	2-10 m	10-25 m	25-50 m	50-100 m	100-200 m	200+ m	Grand Total
Arctic Skua	-	-	1	-	-	-	-	1
Common Gull	1	2	40	21	-	-	-	64
Common Scoter	1	1	-	-	-	-	-	2
Common Tern	1	1	3	-	-	-	-	5
Cormorant	3	1	1	-	-	-	-	5
Eider	3	-	1	-	-	-	-	4
Fulmar	31	13	2	-	-	-	-	46
Northern Gannet	6	12	12	2	-		-	32
Great Black-backed Gull	-	1	8	5	1	1	-	16
Guillemot	15	4	-	-	-	-	-	19
Herring Gull	-	-	16	8	3	2	-	29
Black legged Kittiwake	9	14	50	12	2	-	-	87
Lesser black-backed gull	-	-	1	-	-	-	-	1
Manx shearwater	2	-	-	-	-	-	-	2
Puffin	2	-	-	-	-	-	-	2

Razorbill	12	4	-	-	-	-	-	16
Red throated diver	3	-	4	-	-	-	-	7
Sandwich tern	-	1	7	-	-	-	-	8
Shag	-	1	-	-	-	-	-	1
Common/Arctic Tern	-	-	1	-	-	-	-	1
Guillemot/Razorbill	9	4	-	-	-	-	-	13

Table 8-15: Summary of snapshot counts Phase 2 data, August 2010-January 2012.

Bird Species	Flight height bands							
	0-2 m	2-10 m	10-25 m	25-50 m	50-100 m	100-200 m	200+ m	Grand Total
Arctic Skua	2	2	1	1	-	-	-	6
Arctic Tern	6	15	13	3	-	-	-	37
Common Gull	3	10	36	15	1	1	-	66
Common Scoter	1	-	2	-	-	-	-	3
Common Tern	1	9	4	1	-	-	-	15
Cormorant	6	4	1	1	-	-	-	12
Eider	2	-	-	-	-	-	-	2
Fulmar	21	12	1	-	-	-	-	34
Northern Gannet	37	41	39	5	-	-	-	122
Great Black Backed Gull	7	7	15	3	-	-	-	32
Great Skua	4	1	1	-	-	-	-	6
Guillemot	94	19	4	1	-	-	-	118
Herring Gull	7	10	34	43	5	1	-	100
Black Legged Kittiwake	26	87	104	43	5		-	265
Manx shearwater	6	4	1	-	-	-	-	11
Puffin	7	4	-	-	-	-	-	11
Razorbill	19	6	1	-	-	-	-	26
Red throated Diver	4	6	4	1	-	-	-	15
Sandwich tern	1	3	-	-	-	-	-	4
Shag	11	-	-	-	-	-	-	11

8.9 Flight height distribution of birds in flight (on and off transect) from Phase 1 and Phase 2.

The flight height distribution of birds recorded during snapshot counts and also other observations of birds in flight (off transect) are provided in Table 8-16. Using this information on birds flight height provides a greater number of observations of birds in flight than the snapshot counts alone. The proportion at risk of collision height has been determined for all species and is used within the calculations of collision risk.

Table 8-16 Flight heights of birds captured during snapshot counts and observations of birds in flight (on and off transect) recorded in Phase 1 and Phase 2 surveys.

Species	0-2m	2-10m	10-25m	25-50m	50-100m	100-200m	200+m	Total at flight height	Proportion at collision height 25-200 m %	Total
Arctic Skua	17	17	13	7	2	0	0	9	16.07	56
Arctic Tern	15	65	60	10	1	0	0	11	7.28	151
Common tern	9	53	43	3	0	0	0	3	2.77	108
Sandwich tern	6	25	67	6	0	0	0	6	5.77	104
Common Gull	12	71	443	201	32	1	1	234	30.75	761
Cormorant	87	52	18	3	0	0	0	3	1.88	160
Eider	53	31	13	1	0	0	0	1	1.02	98
Fulmar	560	308	45	4	2	0	0	6	0.65	919
Gannet	533	423	327	109	10	1	0	120	8.55	1403
Great Black Backed Gull	30	46	116	92	33	11	0	136	41.46	328
Great Skua	11	8	7	3	1	0	0	4	13.3	30
Guillemot	1091	477	51	9	1	0	2	10	0.61	1631
Herring Gull	84	248	485	292	72	16	0	380	31.75	1197
Kittiwake	268	912	1092	451	63	4	1	518	18.56	2791
Puffin	112	56	1	0	0	0	0	0	0.00	169
Razorbill	395	242	30	0	1	0	0	1	0.15	668
Red throated Diver	58	68	56	8	1	0	0	9	4.71	191
Common Scoter	35	21	19	0	2	0	0	2	2.60	77
Shag	90	31	5	0	0	0	0	0	0.00	126

8.10 Collision risk calculations

Collision risk calculations have been derived for the species listed in Section 8.1. For each species the flight height densities used within the collision risk model are presented along with the Stage B-E collision risk calculations. An error value has also been attributed to the overall collision risk calculations.

Guillemot

Table 8-17: Guillemot Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.02	0.07	0.09	0.05	0.09	0.00	0.00	0.00	0.05	0.02	0.00
	2008 survey 1	0.00	0.00	-	0.02	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.02	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.00	-	0.00	-
	2011 survey 1	0.32	0.00	0.00	0.00	-	1.12	0.41	0.00	-	-	-	-
	2011 survey 2	-	-	-	-	-	1.84	0.14	0.00		0.49	0.82	-
	2012	0.51	-	-	-	-	-	-	-	-	-	-	-
Mean		0.28	0.01	0.04	0.03	0.05	1.02	0.18	0.00	0.00	0.27	0.28	0.00
Standard deviation		0.26	0.01	0.05	0.04	-	0.88	0.21	0.00	0.00	0.31	0.47	-

Table 8-18: Guillemot collision risk assessment applying EOWDC proportion at risk height (0.61%)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	
Potential bird transits through rotors		47	2	9	7	13	278	50	0	0	54	48	0	**508**	
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	6.4%														
Stage D - multiplying up for entire windfarm and allowing for non operational time															
Collisions assuming no avoidance birds per month or year		3	0	0	0	1	15	3	0	0	3	3	0	**28**	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	0	0	0	0	0	1	0	0	0	0	0	0	**1**	**+/- 1.49**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**+/- 0.60**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.30**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.15**

Table 8-19: Guillemot collision risk assessment applying generic proportion at rotor height (4.14%) (Cook *et al*., 2012)

Stage B - rotor transits		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	-
Potential bird transits through rotors		321	12	59	48	91	1886	336	0	0	368	324	0	**3445**	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	6.4%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		17	1	3	3	5	102	18	0	0	20	18	0	**187**	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	1	0	0	0	0	5	1	0	0	1	1	0	**9**	**+/- 10.10**
	98.00%	0	0	0	0	0	2	0	0	0	0	0	0	**4**	**+/- 4.04**
	99.00%	0	0	0	0	0	1	0	0	0	0	0	0	**2**	**+/- 2.02**
	99.50%	0	0	0	0	0	1	0	0	0	0	0	0	**1**	**+/- 1.01**

Razorbill

Table 8-20: Razorbill Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.00	0.02	0.02	0.05	0.00	0.00	0.00	0.00	0.02	0.00	0.00
	2008 survey 1	0.00	0.02	-	0.11	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.11	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.00	-	0.00	-
	2011 survey 1	0.00	0.00	0.00	0.00	-	0.27	0.09	0.00	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.45	0.23	0.00	-	0.04	0.00	-
	2012	0.09	-	-	-	-	-	-	-	-	-	-	-
Mean		0.03	0.01	0.01	0.06	0.05	0.24	0.11	0.00	0.00	0.03	0.00	0.00
Standard deviation		0.05	0.01	0.01	0.06	-	0.23	0.12	0.00	0.00	0.02	0.00	-

Table 8-21: Razorbill – EOWDC flight heights (0.15%)

Stage B - rotor transits		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	
Potential bird transits through rotors		1	0	1	3	3	16	7	0	0	1	0	0	**33**	
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	6.4%														
Stage D - multiplying up for entire windfarm and allowing for non operational time															
Collisions assuming no avoidance birds per month or year		0	0	0	0	0	1	0	0	0	0	0	0	**2**	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.10**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.04**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.02**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.01**

Table 8-22: Razorbill collision risk assessment applying generic proportion at rotor height (6.77%)(Cook *et al.* 2012)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	
Potential bird transits through rotors		54	18	23	152	144	704	326	0	0	65	0	0	**1486**	
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	6.4%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		3	1	1	8	8	38	18	0	0	4	0	0	**81**	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	0	0	0	0	0	2	1	0	0	0	0	0	**4**	**+/- 4.59**
	98.00%	0	0	0	0	0	1	0	0	0	0	0	0	**2**	**+/- 1.84**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**+/- 0.92**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.46**

Puffin

There were no records of any puffins flying above 25 m in the snapshot counts in the EOWDC surveys, therefore the proportion at risk of collision was 0%. Generic information was used to estimate collision risk by using 6.2% of the birds being at risk.

Table 8-23: Puffin Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00
	2008 survey 1	0.00	0.00	-	0.00	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.00	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.00	-	0.00	-
	2011 survey 1	0.00	0.00	0.00	0.00		0.18	0.09	0.05	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.09	0.09	0.00	-	0.00	0.00	
	2012	0.00	-	-	-	-	-	-	-	-	-	-	-
Mean		0.00	0.00	0.00	0.00	0.00	0.11	0.06	0.02	0.00	0.00	0.00	0.00
Standard deviation		0.00	0.00	0.00	0.00	-	0.07	0.05	0.03	0.00	0.00	0.00	-

Table 8-24: Puffin collision risk assessment applying generic proportion at rotor height (0.02%) (Cook *et al.* 2012)

Stage B - rotor transits		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	
Potential bird transits through rotors		0	0	0	0	0	1	0	0	0	0	0	0	1	
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	6.2%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance	birds per month or year	0	0	0	0	0	0	0	0	0	0	0	0	0	
Stage E - applying avoidance rates															Error margin
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	+/- 0
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	+/- 0
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	+/- 0
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	+/- 0

Fulmar

Table 8-25: Fulmar Phase 1 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.18	0.02	0.02	0.11	0.14	0.05	0.02	0.02	0	0	0.09
	2008 survey 1	0.07	0.02	-	0.14	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.16	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.35	-	0.13	-
	2011 survey 1	0.05	0.00	0.00	0.00	-	0.22	0.18	0.19	-	-		-
	2011 survey 2	-	-	-	-	-	0.04	0.14	0.14	-	0.00	0.14	-
	2012	0.09	-	-	-	-	-	-	-	-	-	-	-
Mean		0.07	0.07	0.01	0.08	0.11	0.14	0.12	0.12	0.18	0.00	0.09	0.09
Standard deviation		0.02	0.10	0.01	0.08	-	0.09	0.07	0.09	0.23	0.00	0.08	-

Table 8-26: Fulmar EOWDC flight heights (0.65%)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	
Potential bird transits through rotors		17	16	3	20	30	37	33	32	45	0	21	22	**275**	
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	7.5%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance	birds per month or year	1	1	0	1	2	2	2	2	3	0	1	1	**17**	**Error margin**
Stage E - applying avoidance rates															
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**+/- 0.68**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.27**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.14**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.07**

Table 8-27: Fulmar collision risk assessment applying generic proportion at rotor height (4.88%) (Cook *et al.* 2012)

Stage B - rotor transits		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	
Potential bird transits through rotors		128	118	19	153	223	279	246	240	339	0	160	163	**2068**	
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	7.5%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		8	7	1	10	14	18	16	15	22	0	10	10	**131**	**Error margin**
Stage E - applying avoidance rates															
Collisions after applying large array correction	95.00%	0	0	0	0	1	1	1	1	1	0	1	1	**7**	**+/- 5.11**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**3**	**+/- 2.05**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**+/- 1.02**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**+/- 0.51**

GENESIS

Common tern

Table 8-28: Common tern Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.00	0.00	0.00	0.02	0.02	0.02	0.05	0.00	0.00	0.00	0.00
	2008 survey 1	0.00	0.00	-	0.00	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.00	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.04	-	0.00	-
	2011 survey 1	0.00	0.00	0.00	0.00		0.04	0.37	0.14	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.04	0.00	0.05	-	0.00	0.00	-
	2012	0.00	-	-	-	-	-	-	-	-	-	-	-
Mean		0.00	0.00	0.00	0.00	0.02	0.04	0.13	0.08	0.02	0.00	0.00	0.00
Standard deviation		0.00	0.00	0.00	0.00	-	0.01	0.21	0.05	0.03	0.00	0.00	-

Table 8-29: Common tern EOWDC flight heights (2.77%)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	
Potential bird transits through rotors		0	0	0	0	14	28	92	50	10	0	0	0	**195**	
Stage C - risk for single rotor transit															
Collision risk for single rotor transit (from sheet 3)	8.5%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance	birds per month or year	0	0	0	0	1	2	7	4	1	0	0	0	**14**	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**+/- 1.14**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.45**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.23**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.11**

Table 8-30: Common tern collision risk assessment applying generic proportion at rotor height (8.26%) (Cook *et al.* 2012)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	
Potential bird transits through rotors		0	0	0	0	41	85	276	150	31	0	0	0	**581**	
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	8.5%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		0	0	0	0	3	6	20	11	2	0	0	0	**42**	
Stage E - applying avoidance rate															**Error margin**
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	1	1	0	0	0	0	**2**	**+/- 3.39**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**+/- 1.36**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.68**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.34**

Sandwich tern

Table 8-31: Sandwich tern Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.00	0.00	0.00	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00
	2008 survey 1	0.00	0.00	0.00	0.00	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.05	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.04	-	0.00	-
	2011 survey 1	0.00	0.00	0.00	0.00	-	0.00	0.09	0.00	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.04	0.00	0.00	-	0.00	0.00	-
	2012	0.00	-	-	-	-	-	-	-	-	-	-	-
Mean		0.00	0.00	0.00	0.01	0.07	0.04	0.03	0.00	0.02	0.00	0.00	0.00
Standard deviation		0.00	0.00	0.00	0.03	-	0.04	0.05	0.00	0.03	0.00	0.00	-

Table 8-32: Sandwich tern EOWDC flight heights (5.77%)

Stage B - rotor transits		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	-
Potential bird transits through rotors		0	0	0	13	105	63	47	0	23	0	0	0	**250**	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	8.2%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		0	0	0	1	7	4	3	0	2	0	0	0	**17**	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**+/- 1.29**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.51**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.26**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.13**

Table 8-33: Sandwich tern collision risk assessment applying generic proportion at rotor height (7.10%) (Cook *et al.* 2012)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	
Potential bird transits through rotors		0	0	0	15	129	77	58	0	28	0	0	0	**307**	
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	8.2%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		0	0	0	1	9	5	4	0	2	0	0	0	**22**	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**+/- 1.16**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.46**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.23**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.12**

Herring Gull

Table 8-34: Herring Gull Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.02	0.07	0.00	0.00	0.05	0.07	0.00	0.00	0.02	0.14	0.02
	2008 survey 1	0.05	0.09	-	0.05	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.09	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.00	-	0.00	-
	2011 survey 1	0.82	0.00	0.00	0.00	-	0.85	0.51	0.14	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.76	0.19	0.05	-	0.13	1.01	
	2012	0.14	-	-	-	-	-	-	-	-	-	-	-
Mean		0.34	0.04	0.04	0.04	0.00	0.56	0.25	0.06	0.00	0.08	0.38	0.02
Standard deviation		0.42	0.05	0.05	0.04	-	0.44	0.23	0.07	0.00	0.08	0.55	-

Table 8-35: Herring Gull EOWDC flight heights (31.75%)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		2774	313	371	384	0	5875	2674	611	0	714	3068	160	**16945**	**-**
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	8.9%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		211	24	28	29	0	447	203	46	0	54	233	12	**1288**	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	11	1	1	1	0	22	10	2	0	3	12	1	**64**	**+/- 65.01**
	98.00%	4	0	1	1	0	9	4	1	0	1	5	0	**26**	**+/- 26.01**
	99.00%	2	0	0	0	0	4	2	0	0	1	2	0	**13**	**+/- 13.01**
	99.50%	1	0	0	0	0	2	1	0	0	0	1	0	**6**	**+/- 6.50**

Table 8-36: Herring Gull collision risk assessment applying generic proportion at rotor height (30.59%) (Cook *et al.* 2012)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		2673	302	358	370	0	5660	2576	589	0	688	2956	154	**16325**	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	8.9%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		203	23	27	28	0	430	196	45	0	52	225	12	**1241**	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	10	1	1	1	0	22	10	2	0	3	11	1	**62**	**+/- 66.98**
	98.00%	4	0	1	1	0	9	4	1	0	1	4	0	**25**	**+/- 26.80**
	99.00%	2	0	0	0	0	4	2	0	0	1	2	0	**12**	**+/- 13.40**
	99.50%	1	0	0	0	0	2	1	0	0	0	1	0	**6**	**+/- 6.70**

Black-legged kittiwake

Table 8-37: Black legged kittiwake Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.02	0.00	0.16	0.36	0.36	0.18	0.27	0.07	0.00	0.00	0.00
	2008 survey 1	0.00	0.00	-	0.16	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.36	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.44	-	0.00	-
	2011 survey 1	0.09	0.00	0.00	0.00	-	1.88	1.89	0.52	-	-	-	-
	2011 survey 2	-	-	-	-	-	2.29	2.05	1.15	-	1.16	0.39	-
	2012	0.28	-	-	-	-	-	-	-	-	-	-	-
Mean		0.12	0.01	0.00	0.17	0.36	1.51	1.37	0.65	0.25	0.58	0.13	0.00
Standard deviation		0.14	0.01	0.00	0.15	-	1.02	1.04	0.46	0.26	0.82	0.22	-

Table 8-38: Black-legged kittiwake EOWDC flight heights (18.56%)

Stage B - rotor transits														**per annum**	**-**
Potential bird transits through rotors		664	53	0	1106	2562	10735	9930	4484	1568	3510	711	0	**35323**	**-**
Stage C - risk for single rotor transit															
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		42	3	0	70	163	683	632	285	100	223	45	0	**2247**	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	2	0	0	4	8	34	32	14	5	11	2	0	**112**	**+/- 90.95**
	98.00%	1	0	0	1	3	14	13	6	2	4	1	0	**45**	**+/- 36.39**
	99.00%	0	0	0	1	2	7	6	3	1	2	0	0	**22**	**+/- 18.20**
	99.50%	0	0	0	0	1	3	3	1	0	1	0	0	**11**	**+/- 9.10**

Table 8-39: Black-legged kittiwake collision risk assessment applying generic proportion at rotor height (16.05%) (Cook *et al.* 2012)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		574	46	0	957	2216	9284	8587	3878	1356	3035	615	0	**30546**	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	7.5%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		37	3	0	61	141	591	546	247	86	193	39	0	**1943**	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	2	0	0	3	7	30	27	12	4	10	2	0	**97**	**+/- 78.63**
	98.00%	1	0	0	1	3	12	11	5	2	4	1	0	**39**	**+/- 31.47**
	99.00%	0	0	0	1	1	6	5	2	1	2	0	0	**19**	**+/- 15.74**
	99.50%	0	0	0	0	1	3	3	1	0	1	0	0	**10**	**+/- 7.87**

Great black-backed gull

Table 8-40: Great Black-backed Gull Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.11
	2008 survey 1	0.11	0.00	-	0.02	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.00	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.00	-	0.00	-
	2011 survey 1	0.05	0.00	0.00	0.00	-	0.04	0.00	0.09	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.04	0.00	0.24	-	0.72	0.14	-
	2012	0.14	-	-	-	-	-	-	-	-	-	-	-
Mean		0.10	0.00	0.01	0.01	0.00	0.03	0.00	0.11	0.00	0.37	0.06	0.11
Standard deviation		0.05	0.00	0.01	0.01	-	0.03	0.00	0.12	0.00	0.49	0.07	-

Table 8-41: Great Black Backed Gull EOWDC flight heights (41.46%)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		1169	0	133	138	0	451	0	1605	0	4734	694	1261	**10185**	**-**
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	8.7%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		87	0	10	10	0	34	0	119	0	352	52	94	**757**	**Error margin**
Stage E - applying avoidance rates															
Collisions after applying large array correction	95.00%	4	0	0	1	0	2	0	6	0	18	3	5	**38**	**+/- 56.74**
	98.00%	2	0	0	0	0	1	0	2	0	7	1	2	**15**	**+/- 22.71**
	99.00%	1	0	0	0	0	0	0	1	0	4	1	1	**8**	**+/- 11.35**
	99.50%	0	0	0	0	0	0	0	1	0	2	0	0	**4**	**+/- 5.68**

Table 8-42: Great Black Backed Gull collision risk assessment applying generic proportion at rotor height (35.05%)(Cook *et al.* 2012)

Stage B - rotor transits			**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors			988	0	112	116	0	381	0	1357	0	4002	587	1066	**8610**	-
Stage C - risk for single rotor transit																
Collision risk for single rotor transit		8.7%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time																
Collisions assuming no avoidance	birds per month or year		73	0	8	9	0	28	0	101	0	298	44	79	**640**	**Error margin**
Stage E - applying avoidance rates																
Collisions after applying large array correction		95.00%	4	0	0	0	0	1	0	5	0	15	2	4	**32**	**+/- 47.97**
		98.00%	1	0	0	0	0	1	0	2	0	6	1	2	**13**	**+/- 19.20**
		99.00%	1	0	0	0	0	0	0	1	0	3	0	1	**6**	**+/- 9.60**
		99.50%	0	0	0	0	0	0	0	1	0	1	0	0	**3**	**+/- 4.80**

Common gull

Table 8-43: Common Gull Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.20	0.05	0.09	0.02	0.00	0.00	0.00	0.02	0.25	0.25	0.16
	2008 survey 1	0.16	0.20	-	0.02	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.02	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.00	-	0.00	-
	2011 survey 1	0.45	0.00	0.00	0.00	-	0.09	0.05	0.00	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.00	0.00	0.00	-	2.02	0.10	-
	2012	0.32	-	-	-	-	-	-	-	-	-	-	-
Mean		0.31	0.13	0.03	0.03	0.02	0.03	0.02	0.00	0.01	1.13	0.12	0.16
Standard deviation		0.15	0.12	0.04	0.04	-	0.05	0.03	0.00	0.01	1.25	0.13	-

Table 8-44: Common Gull EOWDC flight heights (30.75%)

Stage B - rotor transits			**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors			2905	1169	320	331	241	361	246	0	106	11589	1113	1470	**19851**	**-**
Stage C - risk for single rotor transit																
Collision risk for single rotor transit	(from sheet 3)	7.5%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time																
Collisions assuming no avoidance	birds per month or year		186	75	20	21	15	23	16	0	7	740	71	94	**1268**	**Error margin**
Stage E - applying avoidance rates																
Collisions after applying large array correction		95.00%	9	4	1	1	1	1	1	0	0	37	4	5	**63**	**+/- 89.32**
		98.00%	4	1	0	0	0	0	0	0	0	15	1	2	**25**	**+/- 35.74**
		99.00%	2	1	0	0	0	0	0	0	0	7	1	1	**13**	**+/- 17.87**
		99.50%	1	0	0	0	0	0	0	0	0	4	0	0	**6**	**+/- 8.94**

Table 8-45: Common Gull collision risk assessment applying generic proportion at rotor height (22.69%) (Cook *et al.* 2012)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		2144	863	236	244	178	267	181	0	78	8551	821	1084	**14647**	**-**
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	7.5%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		137	55	15	16	11	17	12	0	5	546	52	69	**935**	**Error margin**
Stage E - applying avoidance rates															
Collisions after applying large array correction	95.00%	7	3	1	1	1	1	1	0	0	27	3	3	**47**	**+/- 65.91**
	98.00%	3	1	0	0	0	0	0	0	0	11	1	1	**19**	**+/- 26.37**
	99.00%	1	1	0	0	0	0	0	0	0	5	1	1	**9**	**+/- 13.19**
	99.50%	1	0	0	0	0	0	0	0	0	3	0	0	**5**	**+/- 6.59**

Common scoter

Table 8-46: Common Scoter Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00
	2008 survey 1	0.00	0.00	-	0.00	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.00	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.04	-	0.00	-
	2011 survey 1	0.00	0.00	0.00	0.00	-	0.00	0.05	0.00	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.00	0.00	0.00	-	0.04	0.00	-
	2012	0.00	-	-	-	-	-	-	-	-	-	-	-
Mean		0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.02	0.03	0.01	0.00
Standard deviation		0.00	0.00	0.00	0.00	-	0.00	0.03	0.00	0.03	0.02	0.01	-

Table 8-47: Common Scoter EOWDC flight heights (2.60%)

Stage B - rotor transits			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	-
Potential bird transits through rotors			0	0	0	0	0	0	3	0	3	4	1	0	**12**	-
Stage C - risk for single rotor transit																
Collision risk for single rotor transit		5.9%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time																
Collisions assuming no avoidance	birds per month or year		0	0	0	0	0	0	0	0	0	0	0	0	**1**	**Error margin**
Stage E - applying avoidance rates																
Collisions after applying large array correction		95.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.04**
		98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.01**
		99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.01**
		99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.00**

Table 8-48: Common Scoter collision risk assessment applying generic proportion at rotor height (4.39%) (Cook *et al.* 2012)

Stage B - rotor transits			**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors			0	0	0	0	0	0	58	0	50	72	22	0	**202**	-
Stage C - risk for single rotor transit																
Collision risk for single rotor transit		5.9%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time																
Collisions assuming no avoidance	birds per month or year		0	0	0	0	0	0	3	0	3	4	1	0	**10**	**Error margin**
Stage E - applying avoidance rates																
Collisions after applying large array correction		95.00%	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**+/- 0.63**
		98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.25**
		99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.13**
		99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.06**

Eider

Table 8-49: Eider Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
	2008 survey 1	0.00	0.00	-	0.00	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.02	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.00	-	0.00	-
	2011 survey 1	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	-	-		-
	2011 survey 2	-	-	-	-	-	0.00	0.00	0.00	-	0.00	0.00	-
	2012	0.09	-	-	-	-	-	-	-	-	-	-	-
Mean		0.03	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Standard deviation		0.05	0.00	0.04	0.01	-	0.00	0.00	0.00	0.00	0.01	0.00	-

Table 8-50: Eider EOWDC flight heights (1.02%)

Stage B - rotor transits			**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors			1	0	1	0	0	0	0	0	0	0	0	0	**4**	**-**
Stage C - risk for single rotor transit																
Collision risk for single rotor transit	(from sheet 3)	6.6%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time																
Collisions assuming no avoidance	birds per month or year		0	0	0	0	0	0	0	0	0	0	0	0	**0**	**Error margin**
Stage E - applying avoidance rates																
Collisions after applying large array correction		95.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0**
		98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0**
		99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0**
		99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0**

Table 8-51: Eider collision risk assessment applying generic proportion at rotor height (2.03%)(Cook *et al.* 2012)

Stage B - rotor transits			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	-
Potential bird transits through rotors			25	0	28	10	0	0	0	0	0	9	0	0	**72**	-
Stage C - risk for single rotor transit																
Collision risk for single rotor transit		6.6%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time																
Collisions assuming no avoidance	birds per month or year		1	0	2	1	0	0	0	0	0	1	0	0	**4**	**Error margin**
Stage E - applying avoidance rates																
Collisions after applying large array correction		95.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.22**
		98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.09**
		99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.04**
		99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.02**

Shag

Table 8-52: Shag Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
	2008 survey 1	0.00	0.00	-	0.00	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.00	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.04	-	0.00	-
	2011 survey 1	0.00	0.00	0.00	0.00	-	0.04	0.05	0.05	-	-		-
	2011 survey 2	-	-	-	-	-	0.22	0.00	0.05	-	0.00	0.05	-
	2012	0.00	-	-	-	-	-	-	-	-	-	-	-
Mean		0.00	0.00	0.00	0.00	0.00	0.09	0.02	0.03	0.02	0.00	0.02	0.00
Standard deviation		0.00	0.00	0.00	0.00	-	0.12	0.03	0.03	0.03	0.00	0.02	-

There were no records of any Shag flying above 25 m in the snapshot counts only generic flight height information has been used to estimate collision risk.

Table 8-53: Shag collision risk assessment applying generic proportion at rotor height (13.11%) (Cook *et al.*, 2012)

Stage B - rotor transits			**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors			0	0	0	0	0	452	101	133	73	0	46	0	**805**	**-**
Stage C - risk for single rotor transit																
Collision risk for single rotor transit	(from sheet 3)	7.4%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time																
Collisions assuming no avoidance	birds per month or year		0	0	0	0	0	28	6	8	5	0	3	0	**51**	**Error margin**
Stage E - applying avoidance rates																
Collisions after applying large array correction		95.00%	0	0	0	0	0	1	0	0	0	0	0	0	**3**	**2.73**
		98.00%	0	0	0	0	0	1	0	0	0	0	0	0	**1**	**1.09**
		99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**0.55**
		99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.27**

Cormorant

Table 8-54: Cormorant Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.02	0.02
	2008 survey 1	0.00	0.00	-	0.00	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.02	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.09	-	0.00	-
	2011 survey 1	0.05	0.00	0.00	0.00	-	0.00	0.09	0.00	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.09	0.09	0.10	-	0.00	0.00	-
	2012	0.05	-	-	-	-	-	-	-	-	-	-	-
Mean		0.03	0.01	0.00	0.01	0.00	0.03	0.06	0.03	0.05	0.00	0.01	0.02
Standard deviation		0.03	0.01	0.00	0.01	-	0.05	0.05	0.06	0.05	0.00	0.01	-

Collision risk assessments were calculated using EOWDC data on the proportion at collision height it was not possible to find a generic value for proportion at collision risk height. Cook *et al*., (2011) noted that Cormorants were found to be highly variable in offshore areas and models generated to establish flight heights of cormorants recorded in offshore surveys were unable to produce a mean estimate. Previous investigations of cormorant flight heights estimated a relatively low mean height of 8.3 m (range 1 – 150 m) within a relatively wide range (Walls *et al.* 2004; Parnell *et al.* 2005; Petersen *et al.* 2005).

Table 8-55: Cormorant EOWDC flight heights (1.88%)

Stage B - rotor transits		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	-
Potential bird transits through rotors		9	4	0	6	0	21	43	19	26	0	3	6	136	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	8.0%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		1	0	0	0	0	1	3	1	2	0	0	0	9	Error margin
Stage E - applying avoidance rates															
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	+/- 0.50
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	+/- 0.20
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	+/- 0.10
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	+/- 0.05

Northern Gannet

Table 8-56: Northern Gannet Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.05	0.00	0.02	0.07	0.07	0.07	0.16	0.05	0.16	0.00	0.00
	2008 survey 1	0.00	0.00	-	0.09	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.00	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.52	-	0.00	-
	2011 survey 1	0.00	0.00	0.00	0.00	-	0.54	0.60	0.38	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.40	0.33	0.63	-	2.06	0.10	-
	2012	0.00	-	-	-	-	-	-	-	-	-	-	-
Mean		0.00	0.02	0.00	0.03	0.07	0.34	0.33	0.39	0.29	1.11	0.03	0.00
Standard deviation		0.00	0.03	0.00	0.04	-	0.24	0.26	0.23	0.33	1.34	0.06	-

Table 8-57: Gannet EOWDC flight heights (8.55%)

Stage B - rotor transits			**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors			0	43	0	89	237	1172	1150	1252	809	2825	65	0	**7643**	**-**
Stage C - risk for single rotor transit																
Collision risk for single rotor transit		8.4%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time																
Collisions assuming no avoidance	birds per month or year		0	3	0	6	17	83	82	89	57	201	5	0	**543**	**Error margin**
Stage E - applying avoidance rates																
Collisions after applying large array correction		95.00%	0	0	0	0	1	4	4	4	3	10	0	0	**27**	**32.02**
		98.00%	0	0	0	0	0	2	2	2	1	4	0	0	**11**	**12.81**
		99.00%	0	0	0	0	0	1	1	1	1	2	0	0	**5**	**6.41**
		99.50%	0	0	0	0	0	0	0	0	0	1	0	0	**3**	**3.20**

Table 8-58: Gannet collision risk assessment applying generic proportion at rotor height (15.77%) (Cook *et al.* 2012)

Stage B - rotor transits			**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors			0	80	0	165	437	2162	2122	2310	1492	5211	120	0	**14098**	**-**
Stage C - risk for single rotor transit																
Collision risk for single rotor transit		8.4%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time																
Collisions assuming no avoidance	birds per month or year		0	6	0	12	31	154	151	164	106	370	8	0	**1002**	**Error margin**
Stage E - applying avoidance rates																
Collisions after applying large array correction		95.00%	0	0	0	1	2	8	8	8	5	19	0	0	**50**	**+/- 59.07**
		98.00%	0	0	0	0	1	3	3	3	2	7	0	0	**20**	**+/- 23.63**
		99.00%	0	0	0	0	0	2	2	2	1	4	0	0	**10**	**+/- 11.82**
		99.50%	0	0	0	0	0	1	1	1	1	2	0	0	**5**	**+/- 5.91**

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Red throated diver

Table 8-59: Red throated Diver Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.00	0.02	0.02	0.02	0.00	0.00	0.00	0.05	0.00	0.00	0.05
	2008 survey 1	0.00	0.00	-	0.00	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.00	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.00	-	0.00	-
	2011 survey 1	0.09	0.00	0.00	0.00	-	0.22	0.00	0.00	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.04	0.00	0.00	-	0.04	0.00	-
	2012	0.28	-	-	-	-	-	-	-	-	-	-	-
Mean		0.12	0.00	0.01	0.01	0.02	0.09	0.00	0.00	0.03	0.02	0.00	0.05
Standard deviation		0.14	0.00	0.01	0.01	-	0.12	0.00	0.00	0.04	0.03	0.00	-

Table 8-60: Red throated diver EOWDC flight heights (4.71%)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		113	0	15	17	42	196	0	0	47	26	0	43	**501**	**-**
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	6.6%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance	birds per month or year	6	0	1	1	2	11	0	0	3	1	0	2	**28**	**Error margin**
Stage E - applying avoidance rates															
Collisions after applying large array correction	95.00%	0	0	0	0	0	1	0	0	0	0	0	0	**1**	**+/- 1.99**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**+/- 0.80**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.40**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.20**

Table 8-61: Red throated diver collision risk assessment applying generic proportion at rotor height (3.21%) (Cook *et al.* 2012)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		77	0	10	12	28	134	0	0	32	18	0	29	**341**	**-**
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	6.6%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		4	0	1	1	2	8	0	0	2	1	0	2	**19**	**Error margin**
Stage E - applying avoidance rates															
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**+/- 1.36**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.54**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.27**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.14**

Arctic skua

Table 8-62: Arctic Skua Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
	2008 survey 1	0.00	0.00	-	0.00	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.00	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.04	-	0.00	-
	2011 survey 1	0.00	0.00	0.00	0.00	-	0.00	0.05	0.00	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.00	0.00	0.05	-	0.00	0.00	-
	2012	0.00	-	-	-	-	-	-	-	-	-	-	-
Mean		0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.00	0.00	0.00
Standard deviation		0.00	0.00	0.00	0.00	-	0.00	0.02	0.03	0.03	0.00	0.00	-

Table 8-63: Arctic Skua EOWDC flight heights (16.07%)

Stage B - rotor transits		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	-
Potential bird transits through rotors		0	0	0	0	0	0	96	81	60	0	0	0	**237**	**-**
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	8.3%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		0	0	0	0	0	0	7	6	4	0	0	0	**17**	**Error margin**
Stage E - applying avoidance rates															
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**+/- 1.32**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.53**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.26**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.13**

Table 8-64: Arctic Skua diver collision risk assessment applying generic proportion at rotor height (3.30%) (Cook *et al.* 2012)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		0	0	0	0	0	0	20	17	12	0	0	0	**49**	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	8.3%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		0	0	0	0	0	0	1	1	1	0	0	0	**3**	**Error margin**
Stage E - applying avoidance rates															
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.17**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/-0.13**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.03**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**+/- 0.02**

8.11 Summary of collision risk model

Table 8-65: Summary results of collision risk model applying a range of avoidance rates and EOWDC and Cook *et al*., (2012) proportion at rotor height

Species Name	Collision risk assessment applying EOWDC proportion at collision risk height				Collision risk assessment applying Cook *et al*., (2011) proportion at collision risk height			
	95%	98%	99%	99.5%	95%	98%	99%	99.5%
Guillemot	1 +/- 1.49	1 +/- 0.60	0 +/- 0.30	0+/- 0.15	9 +/- 10.10	4 +/- 4.04	2 +/- 2.02	1 +/- 1.01
Razorbill	0 +/- 0.10	0 +/- 0.04	0 +/- 0.02	0 +/- 0.01	4 +/- 4.59	2 +/- 1.84	1 +/- 0.92	0 +/- 0.46
Puffin	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00
Fulmar	1 +/- 0.68	0 +/- 0.27	0 +/- 0.14	0 +/- 0.07	7 +/- 5.11	3 +/- 2.05	1 +/- 1.02	1 +/- 0.51
Common tern	1 +/- 1.14	0 +/- 0.45	0 +/- 0.23	0 +/- 0.11	2 +/- 3.39	1 +/- 1.36	0 +/- 0.68	0 +/- 0.34
Sandwich tern	1 +/- 1.29	0 +/- 0.51	0 +/- 0.26	0 +/- 0.13	1 +/- 1.16	0 +/- 0.46	0 +/- 0.23	0 +/- 0.12
Herring gull	64 +/- 65.01	26 +/- 26.01	13 +/- 13.01	6 +/- 6.50	62 +/- 66.98	25 +/- 26.80	12 +/- 13.40	6 +/- 6.70
Black-legged kittiwake	112 +/- 90.95	45 +/- 36.39	22 +/- 18.20	11 +/-9.10	97 +/- 78.63	39 +/- 31.47	19 +/- 15.74	10 +/- 7.87
Great black-backed gull	38 +/- 56.74	15 +/- 22.71	8 +/-11.35	4 +/- 5.68	32 +/- 47.97	13 +/- 19.20	6 +/- 9.60	3 +/- 4.80
Common gull	63 +/- 89.32	25 +/- 35.74	13 +/- 17.87	6 +/- 8.94	47 +/- 65.91	19 +/-26.37	9 +/-13.19	5 +/-6.59
Common scoter	0 +/- 0.04	0 +/- 0.01	0 +/- 0.01	0 +/- 0.00	1 +/- 0.63	0 +/- 0.25	0 +/- 0.13	0 +/- 0.06
Eider	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	0 +/- 0.22	0 +/- 0.09	0 +/- 0.04	0 +/- 0.02
Shag	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	3 +/- 2.73	1 +/- 1.09	1+/- 0.55	0 +/- 0.27
Cormorant	0 +/- 0.50	0 +/- 0.20	0 +/- 0.10	0 +/- 0.05	x	x	x	x
Northern Gannet	27 +/- 32.02	11 +/- 12.81	5 +/- 6.41	3 +/- 3.20	50 +/- 59.07	20 +/- 23.63	10 +/- 11.82	5 +/- 5.91
Red throated diver	1 +/- 1.99	1 +/- 0.80	0 +/- 0.40	0 +/- 0.20	1 +/- 1.36	0 +/- 0.54	0 +/- 0.27	0 +/- 0.14
Arctic Skua	1 +/- 1.32	0 +/- 0.53	0 +/- 0.26	0 +/- 0.13	0 +/- 0.17	0 +/- 0.13	0 +/- 0.03	0 +/- 0.02

8.12 Monthly Bird Densities derived from Phase 1 and Phase 2 surveys

Monthly bird densities derived from Phase 1 and Phase 2 surveys are presented in Table 8-66 to Table 8-101.

Table 8-66: Guillemot snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	1	-	-	-	-	-	-	1	0.02
2	March	2007	3	-	-	-	-	-	-	3	0.07
3	April	2007	2	2	-	-	-	-	-	4	0.09
4	May	2007	1	1	-	-	-	-	-	2	0.05
5	June	2007	4	-	-	-	-	-	-	4	0.09
6	July	2007	-	-	-	-	-	-	-	0	0
7	August	2007	-	-	-	-	-	-	-	0	0
8	September	2007	-	-	-	-	-	-	-	0	0
9	October	2007	1	1	-	-	-	-	-	2	0.05
10	November	2007	1	-	-	-	-	-	-	1	0.02
11	December	2007	-	-	-	-	-	-	-	0	0
12	January	2008	-	-	-	-	-	-	-	0	0
13	February	2008	-	-	-	-	-	-	-	0	0
14	April	2008	1	-	-	-	-	-	-	1	0.02
15	April	2008	1	-	-	-	-	-	-	1	0.02
	Total		15	4	-	-	-	-	-	19	0.02

Table 8-67: Guillemot snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	7	-	-	-	-	-	7	0.32
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	23	2	-	-	-	-	-	25	1.12
6	June_2	2011	37	4	-	-	-	-	-	41	1.84
7	July_1	2011	6	1	2	-	-	-	-	9	0.41
8	July_2	2011	-	1	2	-	-	-	-	3	0.14
9	August_1	2010	-	-	-	-	-	-	-	0	0.00
10	August_2	2011	-	-	-	-	-	-	-	0	0.00
11	September	2010	-	-	-	-	-	-	-	0	0.00
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	9	1	-	1	-	-	-	11	0.49
14	November	2011	14	3	-	-	-	-	-	17	0.82
15	January	2012	10	1	-	-	-	-	-	11	0.51
	Total	-	99	20	4	1	-	-	-	124	-

Table 8-68: Razorbill snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	-	-	-	-	-	0	0
2	March	2007	-	1	-	-	-	-	-	1	0.02
3	April	2007	-	1	-	-	-	-	-	1	0.02
4	May	2007	2	-	-	-	-	-	-	2	0.05
5	June	2007	-	-	-	-	-	-	-	0	0
6	July	2007	-	-	-	-	-	-	-	0	0
7	August	2007	-	-	-	-	-	-	-	0	0
8	September	2007	-	-	-	-	-	-	-	0	0
9	October	2007	1	-	-	-	-	-	-	1	0.02
10	November	2007	-	-	-	-	-	-	-	0	0
11	December	2007	-	-	-	-	-	-	-	0	0
12	January	2008	-	-	-	-	-	-	-	0	0
13	February	2008	1	-	-	-	-	-	-	1	0.02
14	April	2008	3	2	-	-	-	-	-	5	0.11
15	April	2008	5	-	-	-	-	-	-	5	0.11
	Total		12	4	-	-	-	-	-	16	-

Table 8-69: Razorbill snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	6	-	-	-	-	-	-	6	0.27
6	June_2	2011	9	1	-	-	-	-	-	10	0.45
7	July_1	2011	1	1	-	-	-	-	-	2	0.09
8	July_2	2011	-	4	1	-	-	-	-	5	0.23
9	August_1	2010	-	-	-	-	-	-	-	0	0.00
10	August_2	2011	-	-	-	-	-	-	-	0	0.00
11	September	2010	-	-	-	-	-	-	-	0	0.00
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	1	-	-	-	-	-	-	1	0.04
14	November	2011	-	-	-	-	-	-	-	0	0.00
15	January	2012	2	-	-	-	-	-	-	2	0.09
	Total	-	19	6	1	-	-	-	-	26	-

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Table 8-70: Puffin snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	-	-	-	-	-	0	0.00
2	March	2007	-	-	-	-	-	-	-	0	0.00
3	April	2007	-	-	-	-	-	-	-	0	0.00
4	May	2007	-	-	-	-	-	-	-	0	0.00
5	June	2007	-	2	-	-	-	-	-	2	0.05
6	July	2007	-	-	-	-	-	-	-	0	0.00
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	-	-	-	-	-	-	-	0	0.00
9	October	2007	-	-	-	-	-	-	-	0	0.00
10	November	2007	-	-	-	-	-	-	-	0	0.00
11	December	2007	-	-	-	-	-	-	-	0	0.00
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	-	-	-	-	-	-	-	0	0.00
15	April	2008	-	-	-	-	-	-	-	0	0.00
	Total		-	2	-	-	-	-	-	2	-

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Table 8-71: Puffin snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	3	1	-	-	-	-	-	4	0.18
6	June_2	2011	2	-	-	-	-	-	-	2	0.09
7	July_1	2011	1	1	-	-	-	-	-	2	0.09
8	July_2	2011	-	2	-	-	-	-	-	2	0.09
9	August_1	2010	1	-	-	-	-	-	-	1	0.05
10	August_2	2011	-	-	-	-	-	-	-	0	0.00
11	September	2010	-	-	-	-	-	-	-	0	0.00
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	-	-	-	-	-	-	0	0.00
14	November	2011	-	-	-	-	-	-	-	0	0.00
15	January	2012	-	-	-	-	-	-	-	0	0.00
	Total	-	7	4	-	-	-	-	-	11	-

Table 8-72: Northern Fulmar snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	7	1	-	-	-	-	-	8	0.18
2	March	2007	1	-	-	-	-	-	-	1	0.02
3	April	2007	-	1	-	-	-	-	-	1	0.02
4	May	2007	4	1	-	-	-	-	-	5	0.11
5	June	2007	5	1	-	-	-	-	-	6	0.14
6	July	2007	1	1	-	-	-	-	-	2	0.05
7	August	2007	1	-	-	-	-	-	-	1	0.02
8	September	2007	-	1	-	-	-	-	-	1	0.02
9	October	2007	-	-	-	-	-	-	-	0	0.00
10	November	2007	-	-	-	-	-	-	-	0	0.00
11	December	2007	-	2	2	-	-	-	-	4	0.09
12	January	2008	3	-	-	-	-	-	-	3	0.07
13	February	2008	1	-	-	-	-	-	-	1	0.02
14	April	2008	5	1	-	-	-	-	-	6	0.14
15	April	2008	3	4	-	-	-	-	-	7	0.16
-	**Total**	-	31	13	2	-	-	-	-	46	-

Table 8-73: Northern Fulmar snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	1	-	-	-	-	-	1	0.05
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	3	2	-	-	-	-	-	5	0.22
6	June_2	2011	-	1	-	-	-	-	-	1	0.04
7	July_1	2011	3	1	-	-	-	-	-	4	0.18
8	July_2	2011	-	3	-	-	-	-	-	3	0.14
9	August_1	2010	3	1	-	-	-	-	-	4	0.19
10	August_2	2011	1	2	-	-	-	-	-	3	0.14
11	September	2010	7	1	-	-	-	-	-	8	0.35
12	November	2010	-	-	-	-	-	-	-	3	0.13
13	October	2011	-	-	-	-	-	-	-	0	0.00
14	November	2011	2	-	1	-	-	-	-	3	0.14
15	January	2012	2	-	-	-	-	-	-	2	0.09
	Total	-	21	12	1	-	-	-	-	34	-

Table 8-74: Common tern snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	-	-	-	-	-	0	0.00
2	March	2007	-	-	-	-	-	-	-	0	0.00
3	April	2007	-	-	-	-	-	-	-	0	0.00
4	May	2007	1	-	-	-	-	-	-	1	0.02
5	June	2007	-	1	-	-	-	-	-	1	0.02
6	July	2007	-	-	1	-	-	-	-	1	0.02
7	August	2007	-	-	2	-	-	-	-	2	0.05
8	September	2007	-	-	-	-	-	-	-	0	0.00
9	October	2007	-	-	-	-	-	-	-	0	0.00
10	November	2007	-	-	-	-	-	-	-	0	0.00
11	December	2007	-	-	-	-	-	-	-	0	0.00
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	-	-	-	-	-	-	-	0	0.00
15	April	2008	-	-	-	-	-	-	-	0	0.00
	Total		1	1	3	-	-	-	-	5	-

Table 8-75: Common tern snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	-	1	-	-	-	-	-	1	0.04
6	June_2	2011	-	1	-	-	-	-	-	1	0.04
7	July_1	2011	1	2	4	1	-	-	-	8	0.37
8	July_2	2011	-	-	-	-	-	-	-	0	0.00
9	August_1	2010	-	3	-	-	-	-	-	3	0.14
10	August_2	2011	-	1	-	-	-	-	-	1	0.05
11	September	2010	-	1	-	-	-	-	-	1	0.04
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	-	-	-	-	-	-	0	0.00
14	November	2011	-	-	-	-	-	-	-	0	0.00
15	January	2012	-	-	-	-	-	-	-	0	0.00
	Total	-	1	9	4	1	-	-	-	15	-

Table 8-76: Sandwich tern snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	-	-	-	-	-	0	0.00
2	March	2007	-	-	-	-	-	-	-	0	0.00
3	April	2007	-	-	-	-	-	-	-	0	0.00
4	May	2007	1	1	1	-	-	-	-	3	0.07
5	June	2007	-	3	-	-	-	-	-	3	0.07
6	July	2007	-	-	-	-	-	-	-	0	0.00
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	-	-	-	-	-	-	-	0	0.00
9	October	2007	-	-	-	-	-	-	-	0	0.00
10	November	2007	-	-	-	-	-	-	-	0	0.00
11	December	2007	-	-	-	-	-	-	-	0	0.00
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	-	-	-	-	-	-	-	0	0.00
15	April	2008	-	1	1	-	-	-	-	2	0.05
	Total		1	5	2	-	-	-	-	8	-

Table 8-77: Sandwich tern snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	-	-	-	-	-	-	-	0	0.00
6	June_2	2011	-	1	-	-	-	-	-	1	0.04
7	July_1	2011	1	1	-	-	-	-	-	2	0.09
8	July_2	2011	-	-	-	-	-	-	-	0	0.00
9	August_1	2010	-	-	-	-	-	-	-	0	0.00
10	August_2	2011	-	-	-	-	-	-	-	0	0.00
11	September	2010	-	1	-	-	-	-	-	1	0.04
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	-	-	-	-	-	-	0	0.00
14	November	2011	-	-	-	-	-	-	-	0	0.00
15	January	2012	-	-	-	-	-	-	-	0	0.00
	Total	-	1	2	-	-	-	-	-	4	-

Table 8-78: Herring gull snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	1	-	-	-	-	1	0.02
2	March	2007	-	-	3	-	-	-	-	3	0.07
3	April	2007	-	-	-	-	-	-	-	0	0.00
4	May	2007	-	-	-	-	-	-	-	0	0.00
5	June	2007	-	-	1	1	-	-	-	2	0.05
6	July	2007	-	-	1	-	2	-	-	3	0.07
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	-	-	-	-	-	-	-	0	0.00
9	October	2007	-	-		1	-	-	-	1	0.02
10	November	2007	-	-	2	4	-	-	-	6	0.14
11	December	2007	-	-	1	-	-	-	-	1	0.02
12	January	2008	-	-	2	-	-	-	-	2	0.05
13	February	2008	-	-	2	-	-	2	-	4	0.09
14	April	2008	-	-	1	1	-	-	-	2	0.05
15	April	2008	-	-	2	1	1	-	-	4	0.09
	Total		-	-	16	8	3	2	-	29	-

Table 8-79: Herring gull snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	1	6	8	2	1	-	18	0.82
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	3	5	8	3	-	-	-	19	0.85
6	June_2	2011	2	1	4	8	2	-	-	17	0.76
7	July_1	2011	-	-	2	9	-	-	-	11	0.51
8	July_2	2011	-	-	2	1	1	-	-	4	0.19
9	August_1	2010	-	-	2	1	-	-	-	3	0.14
10	August_2	2011	1	-	-	-	-	-	-	1	0.05
11	September	2010	-	-	-	-	-	-	-	0	0.00
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	2	-	1	-	-	-	3	0.13
14	November	2011	1	1	8	11	-	-	-	21	1.01
15	January	2012	-	-	2	1	-	-	-	3	0.14
	Total	-	7	10	34	43	5	1	-	100	-

Table 8-80: Black legged kittiwake snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km²)
1	February	2007	-	-	1	-	-	-	-	1	0.02
2	March	2007	-	-	-	-	-	-	-	0	0.00
3	April	2007	-	5	2	-	-	-	-	7	0.16
4	May	2007	2	4	10	-	-	-	-	16	0.36
5	June	2007	3	4	8	-	1	-	-	16	0.36
6	July	2007	-	-	7	1		-	-	8	0.18
7	August	2007	-	-	5	6	1	-	-	12	0.27
8	September	2007	-	-	1	2		-	-	3	0.07
9	October	2007	-	-	-	-	-	-	-	0	0.00
10	November	2007	-	-	-	-	-	-	-	0	0.00
11	December	2007	-	-	-	-	-	-	-	0	0.00
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	2	1	5					7	0.16
15	April	2008	2	-	11	3				16	0.36
	Total	-	9	14	50	12	2	-	-	87	-

Table 8-81: Black legged kittiwake snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	2	-	-	-	-	2	0.09
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	9	30	3	-	-	-	-	42	1.88
6	June_2	2011	9	22	16	4	-	-	-	51	2.29
7	July_1	2011	3	10	23	5	-	-	-	41	1.89
8	July_2	2011	1	6	19	13	-	-	-	44	2.05
9	August_1	2010	3	2	4	2	-	-	-	11	0.52
10	August_2	2011	1	4	16	3	-	-	-	24	1.15
11	September	2010	-	10	-	-	-	-	-	10	0.44
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	2	14	10	-	-	-	26	1.16
14	November	2011	-	1	3	4	-	-	-	8	0.39
15	January	2012	-	-	4	2	-	-	-	6	0.28
	Total	-	26	87	104	43	-	-	-	265	-

Table 8-82: Great Black Back Gull snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	-	-	-	-	-	0	0.00
2	March	2007	-	-	-	1	-	-	-	1	0.02
3	April	2007	-	-	1	-	-	-	-	1	0.02
4	May	2007	-	-	-	-	-	-	-	0	0.00
5	June	2007	-	-	-	-	-	-	-	0	0.00
6	July	2007	-	-	-	-	-	-	-	0	0.00
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	-	-	-	-	-	-	-	0	0.00
9	October	2007	-	-	-	-	-	1	-	1	0.02
10	November	2007	-	-	1	1	-	-	-	2	0.05
11	December	2007	-	-	3	2	-	-	-	5	0.11
12	January	2008	-	1	3	1	-	-	-	5	0.11
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	-	-	-	-	1	-	-	1	0.02
15	April	2008	-	-	-	-	-	-	-	0	0.00
	Total		-	1	8	5	1	1	-	16	-

Table 8-83: Great black backed gull snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	1	-	-	-	-	1	0.05
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	-	1	-	-	-	-	-	1	0.04
6	June_2	2011	-	1	-	-	-	-	-	1	0.04
7	July_1	2011	-	-	-	-	-	-	-	0	0.00
8	July_2	2011	-	-	-	-	-	-	-	0	0.00
9	August_1	2010	-	-	2	-	-	-	-	2	0.09
10	August_2	2011	2	1	1	1				5	0.24
11	September	2010	-	-	-	-	-	-	-	0	0.00
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	3	2	9	2				16	0.72
14	November	2011	2	1	-	-	-	-	-	3	0.14
15	January	2012	-	1	2	-	-	-	-	3	0.14
	Total	-	7	7	15	3	-	-	-	32	-

Table 8-84: Common Gull snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	2	7	-	-	-	-	9	0.20
2	March	2007	-	-	2	-	-	-	-	2	0.05
3	April	2007	-	-	2	2	-	-	-	4	0.09
4	May	2007	-	-	-	1	-	-	-	1	0.02
5	June	2007	-	-	-	-	-	-	-	0	0.00
6	July	2007	-	-	-	-	-	-	-	0	0.00
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	-	-	1	-	-	-	-	1	0.02
9	October	2007	-	-	8	3	-	-	-	11	0.25
10	November	2007	-	-	5	6	-	-	-	11	0.25
11	December	2007	-	-	5	2	-	-	-	7	0.16
12	January	2008	-	-	4	3	-	-	-	7	0.16
13	February	2008	-	-	5	4	-	-	-	9	0.20
14	April	2008	-	-	1	-	-	-	-	1	0.02
15	April	2008	1	-	-	-	-	-	-	1	0.02
	Total		1	2	40	21	-	-	-	64	

Table 8-85: Common gull snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	4	4	1	1	-	10	0.45
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	1	1	-	-	-	-	-	2	0.09
6	June_2	2011	-	-	-	-	-	-	-	0	0.00
7	July_1	2011	-	-	1	-	-	-	-	1	0.05
8	July_2	2011	-	-	-	-	-	-	-	0	0.00
9	August_1	2010	-	-	-	-	-	-	-	0	0.00
10	August_2	2011	-	-	-	-	-	-	-	0	0.00
11	September	2010	-	-	-	-	-	-	-	0	0.00
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	1	8	27	8	-	-	-	45	2.02
14	November	2011	-	1	1	-	-	-	-	2	0.10
15	January	2012	1	1	3	2	-	-	-	7	0.32
	Total	-	3	11	36	15	1	1	-	66	-

Table 8-86: Common scoter snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	-	-	-	-	-	0	0.00
2	March	2007	-	-	-	-	-	-	-	0	0.00
3	April	2007	-	-	-	-	-	-	-	0	0.00
4	May	2007	-	-	-	-	-	-	-	0	0.00
5	June	2007	-	-	-	-	-	-	-	0	0.00
6	July	2007	-	-	-	-	-	-	-	0	0.00
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	-	-	-	-	-	-	-	0	0.00
9	October	2007	-	1	-	-	-	-	-	1	0.02
10	November	2007	1	-	-	-	-	-	-	1	0.02
11	December	2007	-	-	-	-	-	-	-	0	0.00
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	-	-	-	-	-	-	-	0	0.00
15	April	2008	-	-	-	-	-	-	-	0	0.00
	Total		1	1	-	-	-	-	-	2	-

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Table 8-87: Common scoter snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	-	-	-	-	-	-	-	0	0.00
6	June_2	2011	-	-	-	-	-	-	-	0	0.00
7	July_1	2011	-	-	1	-	-	-	-	1	0.05
8	July_2	2011	-	-	-	-	-	-	-	0	0.00
9	August_1	2010	-	-	-	-	-	-	-	0	0.00
10	August_2	2011	-	-	-	-	-	-	-	0	0.00
11	September	2010	1	-	-	-	-	-	-	1	0.04
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	-	1	-	-	-	-	1	0.04
14	November	2011	-	-	-	-	-	-	-	0	0.00
15	January	2012	-	-	-	-	-	-	-	0	0.00
	Total	-	1	-	2	-	-	-	-	3	-

Table 8-88: Eider snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	-	-	-	-	-	0	0.00
2	March	2007	2	-	-	-	-	-	-	2	0.05
3	April	2007	-	-	-	-	-	-	-	0	0.00
4	May	2007	-	-	-	-	-	-	-	0	0.00
5	June	2007	-	-	-	-	-	-	-	0	0.00
6	July	2007	-	-	-	-	-	-	-	0	0.00
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	-	-	-	-	-	-	-	0	0.00
9	October	2007	-	-	1	-	-	-	-	1	0.02
10	November	2007	-	-	-	-	-	-	-	0	0.00
11	December	2007	-	-	-	-	-	-	-	0	0.00
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	-	-	-	-	-	-	-	0	0.00
15	April	2008	1	-	-	-	-	-	-	1	0.02
	Total		3	-	1	-	-	-	-	4	-

Table 8-89: Eider snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	-	-	-	-	-	-	-	0	0.00
6	June_2	2011	-	-	-	-	-	-	-	0	0.00
7	July_1	2011	-	-	-	-	-	-	-	0	0.00
8	July_2	2011	-	-	-	-	-	-	-	0	0.00
9	August_1	2010	-	-	-	-	-	-	-	0	0.00
10	August_2	2011	-	-	-	-	-	-	-	0	0.00
11	September	2010	-	-	-	-	-	-	-	0	0.00
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	-	-	-	-	-	-	0	0.00
14	November	2011	-	-	-	-	-	-	-	0	0.00
15	January	2012	2	-	-	-	-	-	-	2	0.09
	Total	-	2	-	-	-	-	-	-	2	-

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Table 8-90: Shag snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	-	-	-	-	-	0	0.00
2	March	2007	-	-	-	-	-	-	-	0	0.00
3	April	2007	-	-	-	-	-	-	-	0	0.00
4	May	2007	-	-	-	-	-	-	-	0	0.00
5	June	2007	-	-	-	-	-	-	-	0	0.00
6	July	2007	-	-	-	-	-	-	-	0	0.00
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	-	-	-	-	-	-	-	0	0.00
9	October	2007	-	-	-	-	-	-	-	0	0.00
10	November	2007	-	1	-	-	-	-	-	1	0.02
11	December	2007	-	-	-	-	-	-	-	0	0.00
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	-	-	-	-	-	-	-	0	0.00
15	April	2008	-	-	-	-	-	-	-	0	0.00
	Total		-	1	-	-	-	-	-	1	-

Table 8-91: Shag snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	1	-	-	-	-	-	-	1	0.04
6	June_2	2011	5	-	-	-	-	-	-	5	0.22
7	July_1	2011	1	-	-	-	-	-	-	1	0.05
8	July_2	2011	-	-	-	-	-	-	-	0	0.00
9	August_1	2010	1	-	-	-	-	-	-	1	0.05
10	August_2	2011	1	-	-	-	-	-	-	1	0.05
11	September	2010	1	-	-	-	-	-	-	1	0.04
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	-	-	-	-	-	-	0	0.00
14	November	2011	1	-	-	-	-	-	-	1	0.05
15	January	2012		-	-	-	-	-	-	0	0.00
	Total	-	11	-	-	-	-	-	-	11	-

Table 8-92: Cormorant snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	1	-	-	-	-	-	-	1	0.02
2	March	2007	-	-	-	-	-	-	-	0	0.00
3	April	2007	-	-	-	-	-	-	-	0	0.00
4	May	2007	-	-	-	-	-	-	-	0	0.00
5	June	2007	-	-	-	-	-	-	-	0	0.00
6	July	2007	-	-	-	-	-	-	-	0	0.00
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	1	-	-	-	-	-	-	1	0.02
9	October	2007	-	-	-	-	-	-	-	0	0.00
10	November	2007	-	1	-	-	-	-	-	1	0.02
11	December	2007	-	-	1	-	-	-	-	1	0.02
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	-	-	-	-	-	-	-	0	0.00
15	April	2008	1	-	-	-	-	-	-	1	0.02
	Total		3	1	1	-	-	-	-	5	-

Table 8-93: Cormorant snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	1	-	-	-	-	-	1	0.05
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	-	-	-	-	-	-	-	0	0.00
6	June_2	2011	1	-	1	-	-	-	-	2	0.09
7	July_1	2011	-	1	-	1	-	-	-	2	0.09
8	July_2	2011	-	2	-	-	-	-	-	2	0.09
9	August_1	2010	-	-	-	-	-	-	-	0	0.00
10	August_2	2011	2	-	-	-	-	-	-	2	0.10
11	September	2010	2	-	-	-	-	-	-	2	0.09
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	-	-	-	-	-	-	0	0.00
14	November	2011	-	-	-	-	-	-	-	0	0.00
15	January	2012	1	-	-	-	-	-	-	1	0.05
	Total	-	6	4	1	1	-	-	-	12	-

Table 8-94: Northern Gannet snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	1	-	1	-	-	-	-	2	0.05
2	March	2007	-	-	-	-	-	-	-	0	0.00
3	April	2007	-	1	-	-	-	-	-	1	0.02
4	May	2007	1	1	1	-	-	-	-	3	0.07
5	June	2007	-	2	-	1	-	-	-	3	0.07
6	July	2007	1	1	1		-	-	-	3	0.07
7	August	2007	1	2	3	1	-	-	-	7	0.16
8	September	2007	1	1	-	-	-	-	-	2	0.05
9	October	2007	-	2	5	-	-	-	-	7	0.16
10	November	2007	-	-	-	-	-	-	-	0	0.00
11	December	2007	-	-	-	-	-	-	-	0	0.00
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	1	2	1	-	-	-	-	4	0.09
15	April	2008	-	-	-	-	-	-	-	0	0.00
	Total		6	12	12	2	-	-	-	32	-

Table 8-95: Northern Gannet snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	2	5	5	-	-	-	-	12	0.54
6	June_2	2011	4	3	-	2	-	-	-	9	0.40
7	July_1	2011	5	4	4		-	-	-	13	0.60
8	July_2	2011	1	2	2	2	-	-	-	7	0.33
9	August_1	2010	2	2	3	1	-	-	-	8	0.38
10	August_2	2011	1	8	4	-	-	-	-	13	0.63
11	September	2010	3	3	6	-	-	-	-	12	0.52
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	17	14	15	-	-	-	-	46	2.06
14	November	2011	2	-	-	-	-	-	-	2	0.10
15	January	2012	-	-	-	-	-	-	-	0	0.00
	Total	-	37	41	39	5	-	-	-	122	-

Table 8-96: Red-Throated Diver snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	-	-	-	-	-	0	0.00
2	March	2007	1	-	-	-	-	-	-	1	0.02
3	April	2007	-	-	1	-	-	-	-	1	0.02
4	May	2007	-	-	1	-	-	-	-	1	0.02
5	June	2007	-	-	-	-	-	-	-	0	0.00
6	July	2007	-	-	-	-	-	-	-	0	0.00
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	2	-	-	-	-	-	-	2	0.05
9	October	2007	-	-	-	-	-	-	-	0	0.00
10	November	2007	-	-	-	-	-	-	-	0	0.00
11	December	2007	-	-	2	-	-	-	-	2	0.05
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	-	-	-	-	-	-	-	0	0.00
15	April	2008	-	-	-	-	-	-	-	0	0.00
	Total		3	-	4	-	-	-	-	7	-

Table 8-97: Red throated diver snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	1	1	-	-	-	-	2	0.09
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	2	3	-	-	-	-	-	5	0.22
6	June_2	2011	-	1	-	-	-	-	-	1	0.04
7	July_1	2011	-	-	-	-	-	-	-	0	0.00
8	July_2	2011	-	-	-	-	-	-	-	0	0.00
9	August_1	2010	-	-	-	-	-	-	-	0	0.00
10	August_2	2011	-	-	-	-	-	-	-	0	0.00
11	September	2010	-	-	-	-	-	-	-	0	0.00
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	-	1	-	-	-	-	1	0.04
14	November	2011	-	-	-	-	-	-	-	0	0.00
15	January	2012	2	1	2	1	-	-	-	6	0.28
	Total	-	4	6	4	1	-	-	-	15	-

Table 8-98: Arctic Skua snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	-	-	-	-	-	0	0.00
2	March	2007	-	-	-	-	-	-	-	0	0.00
3	April	2007	-	-	-	-	-	-	-	0	0.00
4	May	2007	-	-	-	-	-	-	-	0	0.00
5	June	2007	-	-	-	-	-	-	-	0	0.00
6	July	2007	-	-	1	-	-	-	-	1	0.02
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	-	-	-	-	-	-	-	0	0.00
9	October	2007	-	-	-	-	-	-	-	0	0.00
10	November	2007	-	-	-	-	-	-	-	0	0.00
11	December	2007	-	-	-	-	-	-	-	0	0.00
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	-	-	-	-	-	-	-	0	0.00
15	April	2008	-	-	-	-	-	-	-	0	0.00
	Total		-	-	-	-	-	-	-	1	-

Table 8-99: Arctic Skua snapshot counts, north transect only Phase 2 data August 2010-January 2012.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	-	-	-	-	-	-	-	0	0.00
6	June_2	2011	-	-	-	-	-	-	-	0	0.00
7	July_1	2011	1	-	-	-	-	-	-	1	0.05
8	July_2	2011	-	-	-	-	-	-	-	0	0.00
9	August_1	2010	-	-	-	-	-	-	-	0	0.00
10	August_2	2011	-	-	1	-	-	-	-	1	0.05
11	September	2010	-	1	-	-	-	-	-	1	0.04
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	1	1		1	-	-	-	0	0.00
14	November	2011	-	-	-	-	-	-	-	0	0.00
15	January	2012	-	-	-	-	-	-	-	0	0.00
	Total	-	-	-	-	-	-	-	-	6	-

Table 8-100: Arctic tern snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Monthly Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	-	3	-	-	-	-	-	3	0.13
6	June_2	2011	2	5	-	-	-	-	-	7	0.31
7	July_1	2011	2	2	4	-	-	-	-	8	0.37
8	July_2	2011	-	2	7	3	-	-	-	12	0.56
9	August_1	2010	2	1	-	-	-	-	-	3	0.14
10	August_2	2011	-	2	1	-	-	-	-	3	0.14
11	September	2010	-	-	-	-	-	-	-	0	0.00
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	-	-	-	-	-	-	0	0.00
14	November	2011	-	-	1	-	-	-	-	1	0.05
15	January	2012	-	-	-	-	-	-	-	0	0.00
	Total	-	**6**	**15**	**13**	**3**	**-**	**-**	**-**	**37**	**-**

Table 8-101: Great Skua snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	-	-	-	-	-	-	-	0	0.00
6	June_2	2011	-	-	-	-	-	-	-	0	0.00
7	July_1	2011	-	-	-	-	-	-	-	0	0.00
8	July_2	2011	-	-	-	-	-	-	-	0	0.00
9	August_1	2010	-	-	-	-	-	-	-	0	0.00
10	August_2	2011	-	-	-	-	-	-	-	0	0.00
11	September	2010	1	1	-	-	-	-	-	2	0.09
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	1	-	-	-	-	-	-	1	0.04
14	November	2011	3	-	-	-	-	-	-	3	0.14
15	January	2012		-	-	-	-	-	-	0	0.00
	Total	-	5	1	-	-	-	-	-	6	-

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8.13 Snapshot counts used to derive densities

Table 8-102: Summary of snapshot count used to estimate density of flying birds in Phase 2

Survey ID	Month	Year	Total number of Snapshots	Total area covered by snapshots km^2
1	January	2011	245	22.05
2	February	2011	247	22.23
3	March	2011	250	22.5
4	April	2011	211	18.99
5	June_1	2011	248	22.32
6	June_2	2011	247	22.23
7	July_1	2011	241	21.69
8	July_2	2011	239	21.51
9	August_1	2010	234	21.06
10	August_2	2011	231	20.79
11	September	2010	255	22.95
12	November	2010	254	22.86
13	October	2011	248	22.32
14	November	2011	230	20.7
15	January	2012	240	21.6

Table 8-103: Relative errors produced, note the large standard errors have resulted in the errors being >100% in the majority of species.

Species	Error +/- %
Arctic Skua	159
Arctic Tern	117
Common tern	162
Sandwich tern	147
Common Gull	141
Cormorant	101
Eider	187
Fulmar	78
Gannet	118
Great Black Backed Gull	150
Guillemot	108
Herring Gull	101
Kittiwake	81
Puffin	101
Razorbill	113
Red throated Diver	141
Common Scoter	123
Shag	146

8.14 References

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Birdlife International (2012). Website: http://seabird.wikispaces.com/Sandwich+Tern Date accessed 8/3/2012.

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Species	**Website Address**
Red throated Diver	http://blx1.bto.org/birdfacts/results/bob20.htm
Gannet	http://blx1.bto.org/birdfacts/results/bob710.htm
Common gull	http://blx1.bto.org/birdfacts/results/bob5900.htm
Black legged Kittiwake	http://blx1.bto.org/birdfacts/results/bob6020.htm
Herring gull	http://blx1.bto.org/birdfacts/results/bob5920.htm
Guillemot	http://blx1.bto.org/birdfacts/results/bob6340.htm
Razorbill	http://blx1.bto.org/birdfacts/results/bob6360.htm
Puffin	http://blx1.bto.org/birdfacts/results/bob6540.htm
Fulmar	http://blx1.bto.org/birdfacts/results/bob220.htm
Shag	http://blx1.bto.org/birdfacts/results/bob800.htm
Arctic Skua	http://blx1.bto.org/birdfacts/results/bob5670.htm
Great Skua	http://blx1.bto.org/birdfacts/results/bob5690.htm
Great black-backed gull	http://blx1.bto.org/birdfacts/results/bob6000.htm
Common tern	http://blx1.bto.org/birdfacts/results/bob6150.htm
Sandwich tern	http://blx1.bto.org/birdfacts/results/bob6110.htm
Arctic tern	http://blx1.bto.org/birdfacts/results/bob6160.htm
Eider	http://blx1.bto.org/birdfacts/results/bob2060.htm
Common Scoter	http://blx1.bto.org/birdfacts/results/bob2130.htm
Cormorant	http://blx1.bto.org/birdfacts/results/bob720.htm

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9.0 APPENDIX A1: REVISED COLLISION RISK MODELLING BASED ON AMENDED ROCHDALE ENVELOPE

9.1 Method

The collision risk assessment has followed the Band (2011) guidance and the Strategic Ornithological Support Services (SOSS) worked examples. The collision risk assessment is a six stage process outlined below. The approach taken for each of the six stages will be detailed below.

Stage A – Flight activity

Stage B – Estimating number of bird flights through rotor

Stage C – Probability of collision for a single rotor transit

Stage D – Multiplying to yield expected collisions per year

Stage E – Avoidance and attraction

Stage F – Expressing uncertainty

The collision risk assessment has been completed for the following seventeen species:

18. Guillemot
19. Razorbill
20. Puffin
21. Fulmar
22. Common tern
23. Sandwich tern
24. Herring gull
25. Black-legged kittiwake
26. Great black-backed gull
27. Common gull
28. Common scoter
29. Eider
30. Shag
31. Cormorant
32. Northern Gannet
33. Red throated diver
34. Arctic Skua

9.2 Stage A: Flight Activity

Collision risk assessment requires an estimation of the monthly density of birds in flight. This is derived from the snapshot counts of birds flying in the monthly boat based surveys.

Boat based bird surveys were undertaken as described in Section 0. The first phase (Phase 1) of boat based surveys was carried out in February 2007-April 2008 and consisted of 15 surveys. The second phase (Phase 2) was carried out August 2010-January 2012, and consisted of 15 surveys. The survey areas covered and transect design for Phase 1 and Phase 2 differ, as shown in Figure 9-1 and Figure 9-2.

Phase 1 covered a total survey area of 101.6 km^2, with the total transect length being 148 km. Originally the Phase 1 survey areas separated into a ‘control area’ and a ‘treatment area’ containing the turbines, however it is recognised that the separation true controls with similar environmental conditions are difficult to achieve given far ranging impacts that could extend into the control survey area. For the purposes of estimating flight activity both survey areas in Phase 1 have been used as this encompasses the majority of Aberdeen bay.

Phase 2 adopted a different transect design as illustrated in Figure 9-2. The survey area was extended to the north, south and also included an offshore component. The total survey area was 338.8 km^2 this is divided amongst the north (150.8 km^2), south (82.8 km^2) and offshore (105.2 km^2) survey areas. The transect design changed as a result of an alternation in the proposed turbine layout. Another reason for the change is the increased survey area is expected to improve the monitoring of potentially far field impacts.

For the purposes of estimating bird density all the data collected during Phase 1 will be used, whereas only the North area has been used in the Phase 2 surveys. The majority of bird observations were recorded in the North transect.

Both phases of survey followed the same line transect survey methodology. Linear transects were collected with snapshots of birds collected within a 300 m x 300 m 'box' to the side of the vessel with the best viewing conditions. The total area captured within each snapshot = 0.09 km^2. The total number of birds observed in flight within these snapshots was then divided by the total snapshot area to yield the aerial density of birds in flight. In addition, observations of birds in flight were collected and these were recorded as off effort if they were collected at a distance of 300 m from the vessel or were recorded opportunistically during surveys.

The total number of snapshots conducted in each of the 15 surveys in phase 1 was 493, the total area of captured in snapshots was 44.37 km^2. The survey effort in the 15 surveys carried out in phase 2 was more variable and a range of 230-255 snapshots were collected per survey, the total area captured in the snapshots ranged from 20.7-22.95 km^2 per survey.

The guidance on collision risk assessments recommends using density estimates from the development site. However, the EOWDC crown estate lease area is a relatively small area being only 20 km^2. With snapshots collected every 300 m this would result in only a limited number of counts being collected in the development area. Deriving estimates from a small number of monthly counts (and small snapshot area) may lead to a misrepresentation of densities of birds flying in the development area. The approach taken in this assessment was to derive bird density estimates from Phase 1 and Phase 2 boat based survey (north area only).

For each month a mean density and standard deviation were calculated from all surveys undertaken within that month. The collision risk model evaluates risk on a month by month basis across the year in order to reflect changing bird abundance within the study area.

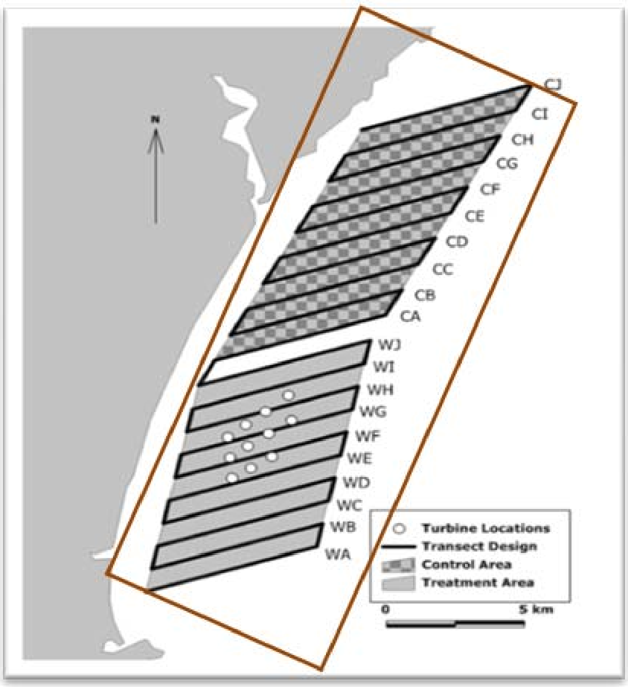

Figure 9-1: Phase 1 survey area consisting of 'Control' and 'Treatment area', all the survey area (outlined with the brown box) was used to estimate bird densities in flight.

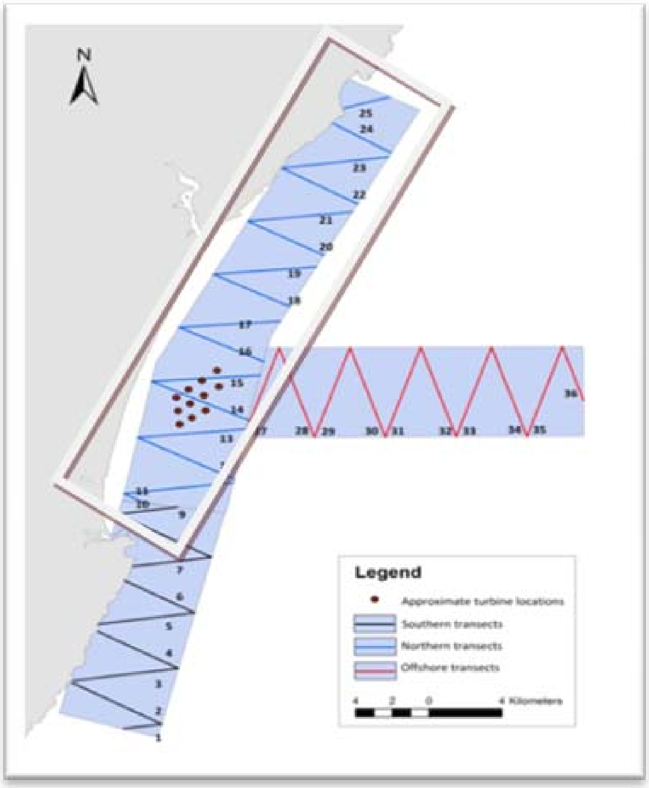

Figure 9-2: Phase 2 survey area consisting of three areas (North, South and Offshore), only the North transect (outlined with the brown box) was used to estimate bird densities in flight.

The distribution of the monthly boat based surveys in Phase 1 and Phase 2 are given in Table 9-1. A number of surveys were missed due to poor survey conditions, when possible duplicate surveys occurred in the next available survey month. May and December are the only months with less than 2 surveys, with 6 months having over 3 surveys

Table 9-2).

Table 9-1: Monthly boat based surveys conducted for the European Offshore Wind Deployment Centre (EOWDC), blue illustrates successful survey, April 2008, June and July 2011 have two surveys.

		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Phase 1 n=15	2007	-											
	2008			-	x 2	-	-	-	-	-	-	-	-
Phase 2 n= 15	2010	-	-	-	-	-	-	-			-		-
	2011					-	x 2	x 2		-			-
	2012	X 2	Ongoing surveys not used in analysis										

Table 9-2: Total number of EOWDC surveys per month collected 2007-2012.

Month	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Total number of surveys	4	3	2	4	1	3	3	3	2	2	2	1

Proportion flying at collision height

The boat based surveys recorded the flight heights of birds using bands of 0 - 2 m, 2 - 10 m, 10 - 25 m, 25 - 50 m, 50 - 100 m, 100 - 200 m and 200 +m. The observations of birds in flight heights were collected during snapshot counts, and also from observations of birds captured when off transect.

The propotion of birds flying at collision height was calculated by the proportion of birds identified as flying within the 25 - 200m.

The results of the number of birds recorded flying at the various height bands and also the proportion flying at risk height recorded from Phase 1 and Phase 2 surveys is given in Table 9-17. The observations of flying birds were taken from all surveys areas for both Phases of boat based surveys.

Nocturnal activity factor

The collision risk assessment takes into consideration the amount of daylight and hours of darkness that birds are expected to be active. Bird species were assigned a nocturnal activity factor this is a six point scoring system between 1-5 designed by Garthe and Hüppop (2004). For example Gannet was assigned a nocturnal activity factor of 2, which translates to approximately 25% activity in comparison to daytime levels. No surveys occurred during hours of darkness at the EOWDC so it was not possible to use site specific data.

EOWDC latitude

The windfarm latitude in decimal degrees is 57° 1' North. This is inputted in the collision risk model to determine the amount of daylight and night time hours, these are used further within the calculations of nocturnal activity and bird density.

Stage A Flight activity example of input parameters into collision risk model

A worked example of Stage A data input parameters into the collision risk model are provided using Gannet as an example.

Table 9-3: Northern Gannet flight densities derived from Phase 1 and Phase 2 surveys.

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Mean density birds/km^2	0.00	0.02	0.00	0.03	0.07	0.34	0.33	0.39	0.29	1.11	0.03	0.00

Proportion flying at risk height	8.55%	Derived from Table 8-16
Nocturnal activity factor	2	Garthe and Hüppop (2004)
Windfarm latitude	57° 1'	EOWDC Latitude

9.2.1 Stage A output parameters

The Stage A output parameters are given in Table 9-4, these are provide the total daylight, night hours and total hours per month, the example provided is for the Gannet.

Table 9-4: Stage A output parameters for the Gannet.

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Daytime aerial bird density	birds/sq km	0	0.02	0	0.03	0.07	0.34	0.33	0.39	0.29	1.11	0.03	0
Proportion at rotor height	% **8.6%**												
Total daylight hours per month	hrs	231	264	365	427	511	534	534	472	386	323	245	212
Total night hours per month	hrs	513	408	379	293	233	186	210	272	334	421	475	532
Total hours per month	hrs	744	672	744	720	744	720	744	744	720	744	720	744

9.3 Stage B: Estimating number of flights through rotors

Stage B will estimate the number of flights through the turbines by a using the Stage A calculations with the design parameters of the EOWDC and also the flight characteristics of the bird species investigated. Input parameters required for Stage B are EOWDC windfarm data and flight speed of bird species.

Wind farm Data

Since the original Rochdale was submitted, a number of turbines are being evaluated both commercially and in terms of innovation content, and this has necessitated a change in some of the input parameters modelled. Consequently, AOWFL carried out an evaluation exercise, which ranked the turbines in terms of their collision risk. The input parameters for the turbines were assessed on the basis of their sensitivity to influence the collision risk outputs. All the turbines were modelled to determine which turbine should be taken forward as the worst case turbine to model (produced the highest number of collisions given a density of flying birds). Due to the non-disclosure agreements which are in place with the turbine manufacturers it is not possible to present the results of the ranking exercise as this would reveal sensitive commercial information such as power curves, rotation speed and rotor dimensions.

The outcome of this evaluation exercise was that the turbine identified as having the highest potential collision risk was selected as the turbine to be modelled. It should be recognised that this turbine did not have the largest diameter of swept area, but due to a combination of factors such as its higher rotational speed it was considered to result in the largest theoretical collision risk.

The EOWDC concept is to deploy a number of different turbines throughout the lease area, yet for the purpose of the collision risk assessment it will be assumed that the same turbine will be installed at all 11 locations. This approach is favoured for a number reasons, firstly it will allow for uncertainty in the configuration of turbines to be factored in and also continue to build a degree of precaution into the collision risk assessment.

Specific changes to the parameters modelled in the updated Rochdale include an increase in rotor diameter, decrease in max chord length, decrease in mean rotations per minute and inclusion of monthly time operational (Table 9-5).

The rotor diameter has increased to 167 m from the value considered in the original Rochdale envelope. This is less than the maximum value supplied in the updated Rochdale (172 m) but corresponds with the other parameters which result in the turbine causing the highest collision risk.

A pitch of 15 degrees is estimated as an average when the turbine is operating at around its mean rotational speed, and this is used throughout the CRM. The variation of pitch along the length of the blades is not provided by manufacturers, nor is data available for the pitch at different wind speeds. It was considered the previous value of 30 degrees was excessive given the expected pitch values form turbines considered. Indeed, the value of 15 degrees is also conservative when consideration is given to the fact that the blades will have near zero pitch angle up until rated speed. Once rated speed is achieved, the blades will begin to pitch in from near zero to their max value (typically 20-25 degrees). Once the max wind speed is observed, the turbine will shut down and cease rotating. As the wind turbine will spend the majority of its time operating below the rated wind speed (typically 80% of the time) the average pitch will be far less than the maximum value.

A max chord length of 5.4 m has been used, this has been derived from a manufactures specification from a 7MW wind turbine, it should be worth noting the max chord length is expected to be less than this and is a precautionary value (Table 9-5).

Table 9-5: Turbine parameters applied in the collision risk model – updated parameters

7 MW turbines	Value	Comments
Rotor diameter	167 m	Derived from manufacturers specifications.
Mean revolutions per minute (rpm)	6.05 rpm	Derived from indicative wind profiles and wind cut out points as per SOSS methodology
Sea clearance rotor tip to sea level	25 m	-
Max chord	5.4 m	Derived from manufacturers specifications
Pitch	15 degrees	Still expected to be conservative

The proportion of time operational was calculated by the proportion of time available Proportion of time available (90%) x proportion of time wind speed is above cut-in and below cut out. The proportion of the time wind speeds were above/below cut-in/cut-out speeds was based on the wind data for the EOWDC development and the turbine specifications. The results of the proportion of time operational are provided for each month in Table 9-6.

Table 9-6: Monthly time operational (%).

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
87	88	87	85	84	85	84	85	86	88	88	88

Stage B Input parameters

The input parameters for stage B are given in Table 9-7. Flight speeds for the bird species assessed were taken from Pennycuick (1987) and Alerstam, 2007, or were derived from a similar species.

Table 9-7: Input parameters for Stage B, windfarm data and bird data (example shown is for the Gannet).

Windfarm data	
Number of turbines	11
Rotor radius	83.5 m
Bird data	**Source**
Gannet flight speed: 14.9 m/sec	(Pennycuick 1987)

Output of Stage B

The output of Stage B determines the potential number of bird transits though the rotors, per month and per annum. Shown in Table 9-8 are the number of rotor transits of gannet through the EOWDC turbines, per month and per annum (6,380 birds/annum). Note that the operational time of the EOWDC turbines has yet to be factored in at this stage in the calculation.

Table 9-8: Stage B rotor transits for the Gannet per month

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum
Potential bird transits through rotors	0	48	0	99	264	1,305	1,281	1,394	901	3,145	72	0	**8,510**

9.4 Stage C: Probability of collision for a single rotor transit

Stage C assess the liklihood of a collision of a bird with a turbine for a single rotor transit. The calculation uses the characteristics of the bird (body size, wing span, flight speed) against the turbine data.

Bird data

The bird data applied in the collision risk model has been derived from a number of sources and is summarised for the species assessed in Table 8-8. British Trust for Ornithology (BTO) bird fact sheets were used to determine values for the body length and wing length. Bird flight speed and nocturnal activity factors are described in Section 9.2.

The collision risk takes into consideration the flight characteristics of the bird, specifically whether the flight is of a flapping or glidding motion. Flapping flight increases the surface area available for a turbine strike. An example is the Gannet, which uses a mixture of flapping and glidding, in the collision risk model this bird has been assessed as flapping which is a more precauitionary basis.

Proportion flying at risk height

The proportion of birds flying at risk height has been determined from two sources, EOWDC boat based survey data and also from a review of bird flight height data compiled by Cook *et al*., 2011. The collision risk assessment has used applied both site specific data collected during the EOWDC surveys, and has also used re-run the assessment using generic flight height data. There were broad similarities in the values produced for the proportion flying at risk height using EOWDC data and the Cook et al., 2011 review.

Proportion flying at risk height EOWDC survey data

The approach taken to determine the proportion of birds flying at risk height derived from EOWDC boat based surveys is described in Section 1. The results are summarised in Table 9-9 and presented further in Section 9.8. The number of samples used to determine the proportion at risk height was n>100 with the exception of eider, cormorant, great skua and Arctic skua. It was considered species with less than 100 observations recorded may not be a representative size to categorise the proportion flying at risk height, and in such cases the Cook *et al*., 2011 proportion at risk height determined may provide a better representation of flight heights.

PROPORTION FLYING AT RISK HEIGHT COOK *ET AL*., (2011) REVIEW

An extensive review of flight height information of birds has been completed by Cook *et al*. 2011. This report determined the proportion of birds that were flying at risk height from the analysis of windfarm bird survey data. In total, data from 38 surveys of 31 existing, proposed or consented offshore wind farms were used in the Cook *et al*., 2011 review.

The proportion flying at risk height has been assessed on the basis of a turbine with rotor blades a minimum of 20 m above sea-level with a diameter of 130 m. The turbine parameters differ to that used in the EOWDC, the result is that this will capture a higher proportion of birds flying at risk height.

Table 9-9 Summary of seabird characteristics used within the collision risk model

Bird species	Bird length (m)	Wingspan (m)	Flight speed m/s	Nocturnal activity Factor 1-5 (Garthe and Huppop 2004)	Flight type (flapping/ gliding)	Proportion at risk height, EOWDC % (Table 9-17))	Proportion at risk height (Cook *et al*, 2011)
	(BTO bird fact sheets, 2011)						
Red throated Diver	0.61	1.11	18.6 (Alerstam, 2007)	1	Flapping	4.71	3.21
Gannet	0.94	1.72	14.9 (Pennycuick 1987)	2	Flapping	8.55	15.77
Common gull	0.41	1.20	13.4 (Alerstam, 2007)	3	Flapping	30.75	22.69
Black legged Kittiwake	0.39	1.08	13.1 (Pennycuick 1987)	3	Flapping	18.56	16.05
Herring gull	0.60	1.44	11.3 (Pennycuick 1987)	3	Flapping	31.75	30.59
Guillemot	0.40	0.70	19.1 (Pennycuick 1987)	2	Flapping	0.61	4.14
Razorbill	0.38	0.66	16.0 (Pennycuick 1987)	1	Flapping	0.15	6.77
Puffin	0.28	0.55	17.6 (Pennycuick 1987)	1	Flapping	0.00	0.02
Fulmar	0.48	1.07	13.0 (Pennycuick 1987)	4	Gliding	0.65	4.88
Shag	0.72	0.98	15.4 (Pennycuick 1987)	1 (used the Cormorant)	Flapping	0	13.11
Arctic Skua	0.44	1.88	13.3 (Pennycuick 1987)	1	Flapping	16.07[2]	3.30
Great Skua	0.56	1.36	14.9 (Pennycuick 1987)	1	Flapping	13.3[2]	6.53
Great black-backed gull	0.71	1.58	12.4 (Pennycuick 1987)	3	Flapping	41.46	35.05
Common tern	0.33	0.88	10.9 (used Arctic Tern)	1	Flapping	2.77	8.26
Sandwich tern	0.38	1.00	13.33 (Bird life international 2012)	1	Flapping	5.77	7.10
Arctic tern	0.34	0.80	10.9 (Alerstam, 2007)	1	Flapping	7.28	4.41
Eider	0.60	0.94	17.9 (Alerstam, 2007)	3	Flapping	1.02[2]	2.03
Common Scoter	0.49	0.84	22.1 (Alerstam, 2007)	3	Flapping	2.60	4.39
Cormorant[1]	0.90	1.45	15.2 (Alerstam, 2007)	1	Flapping	1.88[2]	N/A[1]

1. Flight heights of Cormorants were found to be highly variable in offshore areas, models generated by Cook *et al*., (2011) of flight heights of cormorants recorded in offshore surveys were unable to produce a mean estimate. Previous investigations of cormorant flight heights estimated a relatively low mean height of 8.3 m (range 1 – 150 m) within a relatively wide range (Walls *et al.* 2004; Parnell *et al.* 2005; Petersen *et al.* 2005).

2. Denotes that <100 observations of birds in flight were used to determine proportion at risk.

Stage C: Probability of single collision risk data inputs parameters

The information inputted into the collision risk spreadsheet to in Stage C to assess the probability of a single collision risk is provided in Table 9-10 and Table 9-11.

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Table 9-10: Bird data inputted into collision risk spreadsheet (example Gannet)

Bird data	
Bird Length	0.94m
Wingspan	1.72m
Flight speed	14.9 m/sec
Flight style	Flapping
Proportion of flights upwind	50%

Table 9-11: Turbine parameters inputted into collision risk spreadsheet

Turbine data	
Number of blades	3
Rotor radius	83.5 m
Maximum Chord	5.4m
Average pitch	15^{o}
Rotation speed	6.05 rpm

Stage C output

The output is a calculation of the risk of collision of a bird during a single transit through a turbine. The result is expressed as a percentage risk for upwind and downwind. The average of the risk for upwind and downwind is used for the 'overall collision risk', this is expressed as a percentage. The risk of a collision during a single transit of a Gannet through a turbine in the EOWDC is given in Figure 9-3. The upwind collision is 7.7%, downwind collision is 4.7% with the overall collision being 6.2%.

			Calculation of alpha and p(collision) as a function of radius							
NoBlades	3					Upwind:			Downwind:	
MaxChord	5.40	m	r/R	c/C	α	collide			collide	
Pitch (degrees)	15		radius	chord	alpha	length	p(collision)		length	p(collision)
Species name	Gannet		0.00				1.00			1.00
BirdLength	0.94	m	0.05	0.73	5.63	32.16	0.65		30.12	0.61
Wingspan	1.72	m	0.10	0.79	2.82	17.55	0.36		15.35	0.31
F: flapping (0) or gliding (+1)	0		0.15	0.88	1.88	13.08	0.27		10.62	0.22
Proportion of flights upwind	50%	%	0.20	0.96	1.41	10.82	0.22		8.13	0.17
Bird speed	14.9	m/sec	0.25	1.00	1.13	9.21	0.19		6.42	0.13
Rotor Radius	83.5	m	0.30	0.98	0.94	7.78	0.16		5.04	0.10
Rotation Speed	6.05	rpm	0.35	0.92	0.80	6.53	0.13		3.96	0.08
Rotation Period	9.92	sec	0.40	0.85	0.70	5.52	0.11		3.14	0.06
			0.45	0.80	0.63	4.81	0.10		2.57	0.05
			0.50	0.75	0.56	4.22	0.09		2.12	0.04
Bird aspect ratio: β	0.55		0.55	0.70	0.51	3.79	0.08		1.83	0.04
			0.60	0.64	0.47	3.40	0.07		1.61	0.03
Integration interval	0.05		0.65	0.58	0.43	3.06	0.06		1.44	0.03
			0.70	0.52	0.40	2.76	0.06		1.30	0.03
			0.75	0.47	0.38	2.52	0.05		1.20	0.02
			0.80	0.41	0.35	2.27	0.05		1.12	0.02
			0.85	0.37	0.33	2.10	0.04		1.06	0.02
			0.90	0.30	0.31	1.85	0.04		1.01	0.02
			0.95	0.24	0.30	1.65	0.03		0.98	0.02
			1.00	0.00	0.28	0.94	0.02		0.94	0.02
			Overall p(collision) integrated over disk							
						Upwind	7.7%		Downwind	4.7%
		Proportion	upwind: downwind							
			50%	50%			Average	6.2%	(copied to sheet 1)	

Figure 9-3: Example of the calculation of collision during a single transit through a turbine for the Gannet.

9.5 Stage D: Multiplying to yield expected collisions per year

In this stage the output from Stage B (number of potential transits through rotors) is multiplied by the output of Stage C (collision risk for a single rotor transit). This calculates the projected number of bird collisions per month/year. The collision risk model can make allowance for the proportion of time the turbines are operational. The proportion of time operational depends upon the wind strength and any non-operational time as a result of maintenance. It has not been possible to derive monthly operational figures for the EOWDC turbines. For the purposes of the collision risk assessment a monthly operational time of 85 % has been applied which is in line with industry figures, although it is recognised having a fixed value per month may not reflect better wind speeds in winter, or the increase in maintenance that is typically associated with better weather in the summer months.

Refinement of the proportion of time turbines are operational is possible once the wind frequency distribution at the site is available and assessed against the operating parameters of the turbines to be installed. At this stage a fixed figure of 85% will be used, the proportion of time operational is factored into the error estimate in the collision risk model.

Large array correction factor

A large array correction factor is applied within the collision risk calculation and is used to take into account the change in densities of birds as a result of the removal of animals from collisions as they pass through the array. This calculation is more applicable to large turbine arrays with multiple rows and less so for small arrays like the EOWDC with only 11 turbines arranged into 2 rows.

The application of the large array correction was applied for all species studied and did not change the number of collisions for any of the birds assessed. In all cases the large array factor was >99.94% for the most conservative avoidance factor of 95%. An adjustment of the number of collisions by up to 0.06% is of minor significance to the outputs, especially given the greater influence of some of the other parameters applied within the model such as avoidance rate.

Output

Stage D calculations are given Table 9-12; this is the number of bird collisions (assuming no avoidance) and accounts for non-operational time (85% per month) the example provided is the gannet.

Table 9-12: Output from Stage D: the number of bird collisions (assuming no avoidance) and accounting for non-operational time, (example shown is for the Gannet).

Stage D - multiplying up for entire windfarm and allowing for non-operational time	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Collisions assuming no avoidance birds per month or year	0	3	0	5	14	69	67	74	48	172	4	0	**455**

9.6 Stage E: Avoidance and attraction

The avoidance rate applied within the model is one of the key variables that determine the number of theoretical collisions. The evidence for species-specific avoidance rates to apply in collision risk assessments is incomplete, or absent for the majority of bird species. Collision risks have been calculated for avoidance rates of 95%, 98%, 99% and 99.5%, the collision risk considered to be the most appropriate will be detailed within the bird impact assessment for each species assessed.

The evidence for the windfarm attracting birds like avoidance rates is incomplete, windfarm that attract birds could result in a higher density of animals to be present within the area which would be at risk of future collisions. The evidence for turbines attracting birds will be discussed in the bird impact assessment.

The results of the Collision risk assessment are summarised as follows (using the Gannet as an example). At this stage of the output the uncertainty in the collision risk estimate has yet to be factored in.

Table 9-13: Outputs using SPSS Collision risk spreadsheet, using Gannet as an example.

Stage B	Potential annual bird transits through rotors	8510
Stage C	Risk for a single transit	6.2
	Collisions allowing for non operational time:	
Stage D	Assuming no avoidance	455
Stage E	95%	23
	98%	9
	99%	5
	99.5%	2

9.7 Stage F: Expressing Uncertainty

There are uncertainties in the input data and at several stages in the calculation, and these must be combined to given an understanding of the uncertainty and hence the likely accuracy of the estimated collision risk. The potential number of bird transits through rotors is a product of: Bird density x number of hours active x proportion flying at risk height x total area of rotors x proportion of time operational.

And the total collision risk = potential number of transits x risk during a single transit.

Therefore the errors in each of these elements must be combined to estimate the total error or uncertainty. Each error or uncertainty (e1 – e5) is first expressed as a relative error, i.e. expressed as a fraction or percentage of the value to which it refers.

All the errors are seeking 95% certainty. Thus the range of uncertainty in bird density is taken as two standard deviations from the mean, and the assessment of the accuracy of the flight height observations is based on an expectation that flight height will have been categorised correctly in 95% of cases.

The errors (e) are assessed as follows:

Bird density (e1)

Bird density survey measurements showed variability between surveys and Phases. In Table 8-13 the Fulmar monthly flight densities, mean and standard deviations are given. To calculate the error in the collision estimates for a full year, this is the sum of the collision estimates for each of the twelve months. The annual collision rate depends approximately on the sum of the bird densities for each month. The standard deviation for the sum is obtained by summing the standard deviations, and taking the square root of the sum of squares, to allow for the act that errors in one month may be offset by errors in the other direction in other months. A complication with the EOWDC dataset is that there are 2 months (May and December) that only have 1 survey and it has not been possible to generate a standard deviation for such months. These two months have been removed from the following calculation using monthly standard deviations.

Sum of monthly bird densities = $Mean_{Jan} + Mean_{Feb} + Mean_{March} + Mean_{April} + Mean_{June} + Mean_{Jul} + Mean_{Aug} + Mean_{Sep} + Mean_{Oct} + Mean_{Nov}$

$SD_{year} = \surd(SD_{Jan}^2 + SD_{Feb}^2 + SD_{Mar}^2 + SD_{Apr}^2 + SD_{Jun}^2 + SD_{Jul}^2 + SD_{Aug}^2 + SD_{Sep}^2 + SD_{Oct}^2 + SD_{Nov}^2$

The relative error is:

$$\frac{1.96\ x\ SD_{Year}}{Sum\ of\ monthly\ bird\ densities}$$

For the Fulmar example (mean and standard deviations given in Table 9-14) this is e_1= 0.70. The majority of species assessed had relative errors that were >1.0 (greater than 100%), this is due to the high standard deviations in the monthly survey data.

Table 9-14: Fulmar Phase 1 and Phase 2 flight densities mean and standard deviation

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	2007	-	0.18	0.02	0.02	0.11	0.14	0.05	0.02	0.02	0	0	0.09
	2008 survey 1	0.07	0.02	-	0.14	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.16	-	-	-	-	-	-	-	-
Phase 2	2010	-	-	-	-	-	-	-	-	0.35	-	0.13	-
	2011 survey 1	0.05	0.00	0.00	0.00	-	0.22	0.18	0.19	-	-		-
	2011 survey 2	-	-	-	-	-	0.04	0.14	0.14	-	0.00	0.14	-
	2012	0.09	-	-	-	-	-	-	-	-	-	-	-
Mean		0.07	0.07	0.01	0.08	0.11	0.14	0.12	0.12	0.18	0.00	0.09	0.09
Standard deviation		0.02	0.10	0.01	0.08	-	0.09	0.07	0.09	0.23	0.00	0.08	-

Nocturnal activity (e_2)

Nocturnal activity factors range from 0% (for the majority of birds) to 75% for the Fulmar, the most nocturnally active bird. There is considerable uncertainty in the use of nocturnal activity factors. In the absence of night-time survey data, it is estimated that an uncertainty of +/-10% may be appropriate to apply, the e_2=0.10.

Proportion at risk height (e_3)

The most significant error in relation to flight height is the classification of birds into flight height bands. The observers were all fully trained and checked accuracy of snapshot height estimates periodically, it is possible that some birds may have been classified incorrectly. If the visual estimate were out by +/- 5 m it is estimated that the proportion of birds flying would vary by around +/-25%, the e_3 = 0.25.

Turbine size and time operational (e_4)

It is assumed that the calculation of the turbine dimensions is reasonably accurate. The time operational has been assessed as being 85% each month. 75% may be a more realistic figure in summer months, and 95% in winter when the winds are stronger. Therefore an uncertainty of +/-10% may be appropriate, e_4 = 0.10.

Collision model errors (e_5)

The collision risk model involves a number of simplifications. SOSS (2011) assess an uncertainty of +/-20%, e_5=0.20.

Combining errors

The errors arise independently and so in combining errors it is appropriate to take a root mean square approach, to allow for the likelihood that some errors will offset others.

$E = \sqrt{(e_1^2 + e_2^2 + e_3^2 + e_4^2 + e_5^2)}$

The relative errors produced for the bird species assessed have been applied to the collision risk assessment outputs and have been presented in Table 9-104.

9.8 Results

Flight height distribution from snapshot counts in Phase 1 and Phase 2 surveys.

Snapshot counts were used to derive density of birds in flight that were recorded in transect, summary flight height distribution has been presented for birds recorded in Phase 1 and Phase 2 surveys.

The flight information derived from snapshot counts have been presented for the following species:

Species Name	Flight densities derived from EOWDC surveys		Collision risk estimate produced applying proportion of birds at collision height	
	Phase 1	Phase 2	EOWDC surveys flight data (Table X)	Cook *et al*., flight height data
Guillemot	✓	✓	✓	✓
Razorbill	✓	✓	✓	✓
Puffin	✓	✓	✓	✓
Fulmar	✓	✓	✓	✓
Common tern	✓	✓	✓	✓
Sandwich tern	✓	✓	✓	✓
Arctic tern	x	✓	x	x
Herring gull	✓	✓	✓	✓
Black-legged kittiwake	✓	✓	✓	✓
Great black-backed gull	✓	✓	✓	✓
Common gull,	✓	✓	✓	✓
Common scoter	✓	✓	✓	✓
Eider	✓	✓	✓	✓
Shag	✓	✓	✓	✓
Cormorant	✓	✓	✓	✓
Northern Gannet	✓	✓	✓	✓
Red throated diver	✓	✓	✓	✓
Arctic Skua	✓	✓	✓	✓
Great Skua	x	✓	x	x

Table 9-15: Summary of snapshot counts Phase 1 of survey data February 2007-April 2008.

Bird species	Flight Height bands							
	0-2 m	2-10 m	10-25 m	25-50 m	50-100 m	100-200 m	200+ m	Grand Total
Arctic Skua	-	-	1	-	-	-	-	1
Common Gull	1	2	40	21	-	-	-	64
Common Scoter	1	1	-	-	-	-	-	2
Common Tern	1	1	3	-	-	-	-	5
Cormorant	3	1	1	-	-	-	-	5
Eider	3	-	1	-	-	-	-	4
Fulmar	31	13	2	-	-	-	-	46
Northern Gannet	6	12	12	2	-		-	32
Great Black Backed Gull	-	1	8	5	1	1	-	16
Guillemot	15	4	-	-	-	-	-	19
Herring Gull	-	-	16	8	3	2	-	29
Black legged Kittiwake	9	14	50	12	2	-	-	87
Lesser black backed gull	-	-	1	-	-	-	-	1
Manx shearwater	2	-	-	-	-	-	-	2
Puffin	2	-	-	-	-	-	-	2
Razorbill	12	4	-	-	-	-	-	16
Red throated diver	3	-	4	-	-	-	-	7
Sandwich tern	-	1	7	-	-	-	-	8
Shag	-	1	-	-	-	-	-	1
Common/Arctic Tern	-	-	1	-	-	-	-	1
Guillemot/Razorbill	9	4	-	-	-	-	-	13

Table 9-16: Summary of snapshot counts Phase 2 data, August 2010-January 2012.

Bird Species	Flight height bands							
	0-2 m	2-10 m	10-25 m	25-50 m	50-100 m	100-200 m	200+ m	Grand Total
Arctic Skua	2	2	1	1	-	-	-	6
Arctic Tern	6	15	13	3	-	-	-	37
Common Gull	3	10	36	15	1	1	-	66
Common Scoter	1	-	2	-	-	-	-	3
Common Tern	1	9	4	1	-	-	-	15
Cormorant	6	4	1	1	-	-	-	12
Eider	2	-	-	-	-	-	-	2
Fulmar	21	12	1	-	-	-	-	34
Northern Gannet	37	41	39	5	-	-	-	122
Great Black Backed Gull	7	7	15	3	-	-	-	32
Great Skua	4	1	1	-	-	-	-	6
Guillemot	94	19	4	1	-	-	-	118
Herring Gull	7	10	34	43	5	1	-	100
Black Legged Kittiwake	26	87	104	43	5		-	265
Manx shearwater	6	4	1	-	-	-	-	11
Puffin	7	4	-	-	-	-	-	11
Razorbill	19	6	1	-	-	-	-	26
Red throated Diver	4	6	4	1	-	-	-	15
Sandwich tern	1	3	-	-	-	-	-	4
Shag	11	-	-	-	-	-	-	11

Flight height distribution from observations of all birds in flight (on and off transect) from Phase 1 and Phase 2

The flight height distribution of birds recorded during snapshot counts and also other observations of birds in flight (off transect) are provided in Table 9-17. Using this information on birds flight height provides a greater number of observations of birds in flight than the snapshot counts alone. The proportion at risk of collision height has been determined for all species and is used within the calculations of collision risk.

Table 9-17: Flight heights of birds captured during snapshot counts and observations of birds in flight (on and off transect) recorded in Phase 1 and Phase 2 surveys.

Species	0-2m	2-10m	10-25m	25-50m	50-100m	100-200m	200+m	Total at flight height	Proportion at collision height 25-200 m %	Total
Arctic Skua	17	17	13	7	2	0	0	9	16.07	56
Arctic Tern	15	65	60	10	1	0	0	11	7.28	151
Common tern	9	53	43	3	0	0	0	3	2.77	108
Sandwich tern	6	25	67	6	0	0	0	6	5.77	104
Common Gull	12	71	443	201	32	1	1	234	30.75	761
Cormorant	87	52	18	3	0	0	0	3	1.88	160
Eider	53	31	13	1	0	0	0	1	1.02	98
Fulmar	560	308	45	4	2	0	0	6	0.65	919
Gannet	533	423	327	109	10	1	0	120	8.55	1403
Great Black Backed Gull	30	46	116	92	33	11	0	136	41.46	328
Great Skua	11	8	7	3	1	0	0	4	13.3	30
Guillemot	1091	477	51	9	1	0	2	10	0.61	1631
Herring Gull	84	248	485	292	72	16	0	380	31.75	1197
Kittiwake	268	912	1092	451	63	4	1	518	18.56	2791
Puffin	112	56	1	0	0	0	0	0	0.00	169
Razorbill	395	242	30	0	1	0	0	1	0.15	668
Red throated Diver	58	68	56	8	1	0	0	9	4.71	191
Common Scoter	35	21	19	0	2	0	0	2	2.60	77
Shag	90	31	5	0	0	0	0	0	0.00	126

9.9 Collision risk calculations

Collision risk calculations have been derived for the species listed in Section 9.1. For each species the flight height densities used within the collision risk model are presented along with the Stage B-E collision risk calculations. An error value has also been attributed to the overall collision risk calculations.

Guillemot

Table 9-18: Guillemot Phase 1 and Phase 2 flight densities.

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.02	0.07	0.09	0.05	0.09	0.00	0.00	0.00	0.05	0.02	0.00
	2008 survey 1	0.00	0.00	-	0.02	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.02	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.00	-	0.00	-
	2011 survey 1	0.32	0.00	0.00	0.00	-	1.12	0.41	0.00	-	-	-	-
	2011 survey 2	-	-	-	-	-	1.84	0.14	0.00		0.49	0.82	-
	2012	0.51	-	-	-	-	-	-	-	-	-	-	-
Mean		0.28	0.01	0.04	0.03	0.05	1.02	0.18	0.00	0.00	0.27	0.28	0.00
Standard deviation		0.26	0.01	0.05	0.04	-	0.88	0.21	0.00	0.00	0.31	0.47	-

Table 9-19: Guillemot collision risk assessment applying EOWDC proportion at risk height (0.61%).

Stage B - rotor transits		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	-
Potential bird transits through rotors		53	2	10	8	15	309	55	0	0	60	53	0	565	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	4.8%														
Stage D - multiplying up for entire windfarm and allowing for non operational time															
Collisions assuming no avoidance birds per month or year		2	0	0	0	1	13	2	0	0	3	2	0	23	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	0	0	0	0	0	1	0	0	0	0	0	0	1	**+/- 1.49**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.60**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/-0.30**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.15**

Table 9-20: Guillemot collision risk assessment applying generic proportion at rotor height (4.14%) (Cook *et al*., 2011).

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		357	13	65	53	101	2100	375	0	0	410	361	0	3835	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	4.8%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		15	1	3	2	4	85	15	0	0	17	15	0	**157**	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	1	0	0	0	0	4	1	0	0	1	1	0	8	**+/- 10.10**
	98.00%	0	0	0	0	0	2	0	0	0	0	0	0	3	**+/- 4.04**
	99.00%	0	0	0	0	0	1	0	0	0	0	0	0	2	**+/- 2.02**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	1	**+/- 1.01**

Razorbill

Table 9-21: Razorbill Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.00	0.02	0.02	0.05	0.00	0.00	0.00	0.00	0.02	0.00	0.00
	2008 survey 1	0.00	0.02	-	0.11	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.11	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.00	-	0.00	-
	2011 survey 1	0.00	0.00	0.00	0.00	-	0.27	0.09	0.00	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.45	0.23	0.00	-	0.04	0.00	-
	2012	0.09	-	-	-	-	-	-	-	-	-	-	-
Mean		0.03	0.01	0.01	0.06	0.05	0.24	0.11	0.00	0.00	0.03	0.00	0.00
Standard deviation		0.05	0.01	0.01	0.06	-	0.23	0.12	0.00	0.00	0.02	0.00	-

Table 9-22 Razorbill – EOWDC flight heights (0.15%)

Stage B - rotor transits		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	-
Potential bird transits through rotors		1	0	1	4	4	17	8	0	0	2	0	0	37	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	4.7%														
Stage D - multiplying up for entire windfarm and allowing for non operational time															
Collisions assuming no avoidance birds per month or year		0	0	0	0	0	1	0	0	0	0	0	0	1	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.10**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/-0.04**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/-0.02**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/-0.01**

Table 9-23 Razorbill collision risk assessment applying generic proportion at rotor height (6.77%)(Cook *et al*., 2011)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		61	21	26	169	160	783	363	0	0	72	0	0	1655	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	4.7%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		3	1	1	7	6	32	14	0	0	3	0	0	67	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	0	0	0	0	0	2	1	0	0	0	0	0	3	**+/- 3.77**
	98.00%	0	0	0	0	0	1	0	0	0	0	0	0	1	**+/- 1.51**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	1	**+/- 0.75**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.38**

Puffin

There were no records of any puffins flying above 25 m in the snapshot counts in the EOWDC surveys, therefore the proportion at risk of collision was 0%. Generic information was used to estimate collision risk by using 6.2% of the birds being at risk.

Table 9-24: Puffin Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00
	2008 survey 1	0.00	0.00	-	0.00	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.00	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.00	-	0.00	-
	2011 survey 1	0.00	0.00	0.00	0.00		0.18	0.09	0.05	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.09	0.09	0.00	-	0.00	0.00	
	2012	0.00	-	-	-	-	-	-	-	-	-	-	-
Mean		0.00	0.00	0.00	0.00	0.00	0.11	0.06	0.02	0.00	0.00	0.00	0.00
Standard deviation		0.00	0.00	0.00	0.00	-	0.07	0.05	0.03	0.00	0.00	0.00	-

Table 9-25 Puffin collision risk assessment applying generic proportion at rotor height (0.02%) (Cook *et al*., 2011)

Stage B - rotor transits			**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors			0	0	0	0	0	1	1	0	0	0	0	0	2	**-**
Stage C - risk for single rotor transit																
Collision risk for single rotor transit		4.5%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time																
Collisions assuming no avoidance	birds per month or year		0	0	0	0	0	0	0	0	0	0	0	0	0	
Stage E - applying avoidance rates																**Error margin**
Collisions after applying large array correction		95.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.00**
		98.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.00**
		99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.00**
		99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.00**

Fulmar

Table 9-26: Fulmar Phase 1 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.18	0.02	0.02	0.11	0.14	0.05	0.02	0.02	0	0	0.09
	2008 survey 1	0.07	0.02	-	0.14	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.16	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.35	-	0.13	-
	2011 survey 1	0.05	0.00	0.00	0.00	-	0.22	0.18	0.19	-	-		-
	2011 survey 2	-	-	-	-	-	0.04	0.14	0.14	-	0.00	0.14	-
	2012	0.09	-	-	-	-	-	-	-	-	-	-	-
Mean		0.07	0.07	0.01	0.08	0.11	0.14	0.12	0.12	0.18	0.00	0.09	0.09
Standard deviation		0.02	0.10	0.01	0.08	-	0.09	0.07	0.09	0.23	0.00	0.08	-

Table 9-27 Fulmar EOWDC flight heights (0.65%)

Stage B - rotor transits		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	
Potential bird transits through rotors		19	18	3	23	33	41	36	36	50	0	24	24	307	
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	5%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance	birds per month or year	1	1	0	1	1	2	2	2	2	0	1	1	13	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	1	**+/- 0.78**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.00**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.00**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.00**

Table 9-28 Fulmar collision risk assessment applying generic proportion at rotor height (4.88%) (Cook *et al*., 2011)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		142	131	21	171	249	311	273	267	377	0	178	181	2302	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	5%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		6	6	1	7	11	13	12	11	16	0	8	8	100	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	0	0	0	0	1	1	1	1	1	0	0	0	5	**+/- 3.90**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	2	**+/- 1.56**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	1	**+/- 0.78**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.39**

Common tern

Table 9-29: Common tern Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.00	0.00	0.00	0.02	0.02	0.02	0.05	0.00	0.00	0.00	0.00
	2008 survey 1	0.00	0.00	-	0.00	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.00	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.04	-	0.00	-
	2011 survey 1	0.00	0.00	0.00	0.00		0.04	0.37	0.14	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.04	0.00	0.05	-	0.00	0.00	-
	2012	0.00	-	-	-	-	-	-	-	-	-	-	-
Mean		0.00	0.00	0.00	0.00	0.02	0.04	0.13	0.08	0.02	0.00	0.00	0.00
Standard deviation		0.00	0.00	0.00	0.00	-	0.01	0.21	0.05	0.03	0.00	0.00	-

Table 9-30 Common tern EOWDC flight heights (2.77%)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		0	0	0	0	15	32	103	56	11	0	0	0	217	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit (from sheet 3)	5.1%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance	birds per month or year	0	0	0	0	1	1	4	2	1	0	0	0	9	
															Error margin
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.76**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.30**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.15**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.08**

Table 9-31 Common tern collision risk assessment applying generic proportion at rotor height (8.26%) (Cook *et al*., 2011)

Stage B - rotor transits		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	
Potential bird transits through rotors		0	0	0	0	45	94	307	167	34	0	0	0	647	
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	5.1%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		0	0	0	0	2	4	13	7	2	0	0	0	28	
Stage E - applying avoidance rate															**Error margin**
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	1	0	0	0	0	0	1	**+/- 2.27**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	1	**+/- 0.91**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.45**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.23**

Sandwich tern

Table 9-32: Sandwich tern Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.00	0.00	0.00	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00
	2008 survey 1	0.00	0.00	0.00	0.00	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.05	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.04	-	0.00	-
	2011 survey 1	0.00	0.00	0.00	0.00	-	0.00	0.09	0.00	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.04	0.00	0.00	-	0.00	0.00	-
	2012	0.00	-	-	-	-	-	-	-	-	-	-	-
Mean		0.00	0.00	0.00	0.01	0.07	0.04	0.03	0.00	0.02	0.00	0.00	0.00
Standard deviation		0.00	0.00	0.00	0.03	-	0.04	0.05	0.00	0.03	0.00	0.00	-

Table 9-33 Sandwich tern EOWDC flight heights (5.77%)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		0	0	0	14	117	70	52	0	25	0	0	0	278	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	5.2%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		0	0	0	1	5	3	2	0	1	0	0	0	12	
															Error margin
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	1	**+/- 0.89**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.36**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.18**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.09**

Table 9-34 Sandwich tern collision risk assessment applying generic proportion at rotor height (7.10%) (Cook *et al*., 2011)

Stage B - rotor transits		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	-
Potential bird transits through rotors		0	0	0	17	144	86	64	0	31	0	0	0	342	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	5.2%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		0	0	0	1	6	4	3	0	1	0	0	0	0	
															Error margin
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	1	**+/- 0.80**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.32**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.16**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.08**

Herring Gull

Table 9-35: Herring Gull Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.02	0.07	0.00	0.00	0.05	0.07	0.00	0.00	0.02	0.14	0.02
	2008 survey 1	0.05	0.09	-	0.05	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.09	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.00	-	0.00	-
	2011 survey 1	0.82	0.00	0.00	0.00	-	0.85	0.51	0.14	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.76	0.19	0.05	-	0.13	1.01	
	2012	0.14	-	-	-	-	-	-	-	-	-	-	-
Mean		0.34	0.04	0.04	0.04	0.00	0.56	0.25	0.06	0.00	0.08	0.38	0.02
Standard deviation		0.42	0.05	0.05	0.04	-	0.44	0.23	0.07	0.00	0.08	0.55	-

Table 9-36 Herring Gull EOWDC flight heights (31.75%)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		3089	349	413	428	0	6541	2977	680	0	795	3415	178	18865	**-**
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	5.9%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		158	18	21	21	0	326	147	34	0	41	176	9	951	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	8	1	1	1	0	16	7	2	0	2	9	0	48	**+/- 48.02**
	98.00%	3	0	0	0	0	7	3	1	0	1	4	0	19	**+/- 19.02**
	99.00%	2	0	0	0	0	3	1	0	0	0	2	0	10	**+/- 9.61**
	99.50%	1	0	0	0	0	2	1	0	0	0	1	0	5	**+/- 4.80**

Table 9-37 Herring Gull collision risk assessment applying generic proportion at rotor height (30.59%) (Cook *et al*., 2011)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		2976	336	398	412	0	6302	2868	655	0	766	3291	172	18176	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	5.9%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		152	17	20	21	0	314	141	33	0	40	170	9	916	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	8	1	1	1	0	16	7	2	0	2	8	0	46	**+/- 46.26**
	98.00%	3	0	0	0	0	6	3	1	0	1	3	0	18	**+/- 18.51**
	99.00%	2	0	0	0	0	3	1	0	0	0	2	0	9	**+/- 9.26**
	99.50%	1	0	0	0	0	2	1	0	0	0	1	0	5	**+/- 4.63**

Black-legged kittiwake

Table 9-38: Black legged kittiwake Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.02	0.00	0.16	0.36	0.36	0.18	0.27	0.07	0.00	0.00	0.00
	2008 survey 1	0.00	0.00	-	0.16	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.36	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.44	-	0.00	-
	2011 survey 1	0.09	0.00	0.00	0.00	-	1.88	1.89	0.52	-	-	-	-
	2011 survey 2	-	-	-	-	-	2.29	2.05	1.15	-	1.16	0.39	-
	2012	0.28	-	-	-	-	-	-	-	-	-	-	-
Mean		0.12	0.01	0.00	0.17	0.36	1.51	1.37	0.65	0.25	0.58	0.13	0.00
Standard deviation		0.14	0.01	0.00	0.15	-	1.02	1.04	0.46	0.26	0.82	0.22	-

Table 9-39 Black legged kittiwake EOWDC flight heights (18.56%)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		739	59	0	1232	2853	11952	11055	4993	1745	3908	792	0	39327	**-**
Stage C - risk for single rotor transit	5.1%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		33	3	0	54	123	522	477	218	77	177	36	0	1720	
															Error margin
Collisions after applying large array correction	95.00%	2	0	0	3	6	26	24	11	4	9	2	0	86	**+/- 69.64**
	98.00%	1	0	0	1	2	10	10	4	2	4	1	0	34	**+/- 27.86**
	99.00%	0	0	0	1	1	5	5	2	1	2	0	0	17	**+/- 13.93**
	99.50%	0	0	0	0	1	3	2	1	0	1	0	0	9	**+/- 6.97**

GENESIS

Table 9-40 Black legged kittiwake collision risk assessment applying generic proportion at rotor height (16.05%) (Cook *et al*., 2011)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		639	51	0	1065	2467	10336	9560	4317	1509	3379	685	0	34008	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	5.1%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		29	2	0	47	107	452	413	189	67	153	31	0	29	
															Error margin
Collisions after applying large array correction	95.00 %	1	0	0	2	5	23	21	9	3	8	2	0	74	**+/- 60.22**
	98.00 %	1	0	0	1	2	9	8	4	1	3	1	0	30	**+/- 24.99**
	99.00 %	0	0	0	0	1	5	4	2	1	2	0	0	15	**+/- 12.05**
	99.50 %	0	0	0	0	1	2	2	1	0	1	0	0	7	**+/- 6.02**

Great black backed gull

Table 9-41: Great Black Backed Gull Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.11
	2008 survey 1	0.11	0.00	-	0.02	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.00	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.00	-	0.00	-
	2011 survey 1	0.05	0.00	0.00	0.00	-	0.04	0.00	0.09	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.04	0.00	0.24	-	0.72	0.14	-
	2012	0.14	-	-	-	-	-	-	-	-	-	-	-
Mean		0.10	0.00	0.01	0.01	0.00	0.03	0.00	0.11	0.00	0.37	0.06	0.11
Standard deviation		0.05	0.00	0.01	0.01	-	0.03	0.00	0.12	0.00	0.49	0.07	-

Table 9-42 Great Black Backed Gull EOWDC flight heights (41.46%)

Stage B - rotor transits		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	-
Potential bird transits through rotors		1302	0	148	153	0	502	0	1787	0	5271	773	1403	11339	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	6.0%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		68	0	8	8	0	26	0	91	0	279	41	74	595	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	3	0	0	0	0	1	0	5	0	14	2	4	30	**+/- 44.58**
	98.00%	1	0	0	0	0	1	0	2	0	6	1	1	12	**+/- 17.84**
	99.00%	1	0	0	0	0	0	0	1	0	3	0	1	6	**+/- 8.92**
	99.50%	0	0	0	0	0	0	0	0	0	1	0	0	3	**+/- 4.46**

Table 9-43 Great Black Backed Gull collision risk assessment applying generic proportion at rotor height (35.05%)(Cook *et al*., 2011)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		1100	0	125	129	0	424	0	1510	0	4456	653	1187	9586	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	6.0%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance	birds per month or year	58	0	7	7	0	22	0	77	0	236	35	63	503	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	3	0	0	0	0	1	0	4	0	12	2	3	25	**+/- 37.69**
	98.00%	1	0	0	0	0	0	0	2	0	5	1	1	10	**+/- 15.08**
	99.00%	1	0	0	0	0	0	0	1	0	2	0	1	5	**+/- 7.54**
	99.50%	0	0	0	0	0	0	0	0	0	1	0	0	3	**+/- 3.77**

Common gull

Table 9-44: Common Gull Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.20	0.05	0.09	0.02	0.00	0.00	0.00	0.02	0.25	0.25	0.16
	2008 survey 1	0.16	0.20	-	0.02	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.02	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.00	-	0.00	-
	2011 survey 1	0.45	0.00	0.00	0.00	-	0.09	0.05	0.00	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.00	0.00	0.00	-	2.02	0.10	-
	2012	0.32	-	-	-	-	-	-	-	-	-	-	-
Mean		0.31	0.13	0.03	0.03	0.02	0.03	0.02	0.00	0.01	1.13	0.12	0.16
Standard deviation		0.15	0.12	0.04	0.04	-	0.05	0.03	0.00	0.01	1.25	0.13	-

Table 9-45 Common Gull EOWDC flight heights (30.75%)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		3234	1302	356	368	269	402	274	0	118	12902	1239	1636	22100	**-**
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	5.1%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		148	60	16	16	12	18	12	0	5	596	57	76	1016	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	7	3	1	1	1	1	1	0	0	30	3	4	51	**+/- 71.58**
	98.00%	3	1	0	0	0	0	0	0	0	12	1	2	20	**+/- 28.64**
	99.00%	1	1	0	0	0	0	0	0	0	6	1	1	10	**+/- 14.32**
	99.50%	1	0	0	0	0	0	0	0	0	3	0	0	5	**+/- 7.16**

Table 9-46 Common Gull collision risk assessment applying generic proportion at rotor height (22.69%) (Cook *et al*., 2011)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		2387	961	263	272	198	297	202	0	87	9520	914	1207	16307	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	5.1%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		109	44	12	12	9	13	9	0	4	439	42	56	749	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	5	2	1	1	0	1	0	0	0	22	2	3	37	**+/- 52.82**
	98.00%	2	1	0	0	0	0	0	0	0	9	1	1	15	**+/- 21.13**
	99.00%	1	0	0	0	0	0	0	0	0	4	0	1	7	**+/- 10.57**
	99.50%	1	0	0	0	0	0	0	0	0	2	0	0	4	**+/- 5.28**

Common scoter

Table 9-47: Common Scoter Phase 1 and Phase 2 flight densities

		January	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Phase 1	**2007**	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00
	2008 survey 1	0.00	0.00	-	0.00	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.00	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.04	-	0.00	-
	2011 survey 1	0.00	0.00	0.00	0.00	-	0.00	0.05	0.00	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.00	0.00	0.00	-	0.04	0.00	-
	2012	0.00	-	-	-	-	-	-	-	-	-	-	-
Mean		0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.02	0.03	0.01	0.00
Standard deviation		0.00	0.00	0.00	0.00	-	0.00	0.03	0.00	0.03	0.02	0.01	-

Table 9-48 Common Scoter EOWDC flight heights (2.60%)

Stage B - rotor transits		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	-
Potential bird transits through rotors		0	0	0	0	0	0	4	0	3	5	1	0	13	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	4.8%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance	birds per month or year	0	0	0	0	0	0	0	0	0	0	0	0	1	
															Error margin
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.03**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.01**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.01**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.00**

Table 9-49 Common Scoter collision risk assessment applying generic proportion at rotor height (4.39%) (Cook *et al*., 2011)

Stage B - rotor transits		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	-
Potential bird transits through rotors		0	0	0	0	0	0	64	0	56	81	24	0	225	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	4.8%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance	birds per month or year	0	0	0	0	0	0	3	0	2	3	1	0	9	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0		**+/- 0.58**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0		**+/- 0.23**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0		**+/-0.12**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0		**+/- 0.06**

Eider

Table 9-50: Eider Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
	2008 survey 1	0.00	0.00	-	0.00	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.02	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.00	-	0.00	-
	2011 survey 1	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	-	-		-
	2011 survey 2	-	-	-	-	-	0.00	0.00	0.00	-	0.00	0.00	-
	2012	0.09	-	-	-	-	-	-	-	-	-	-	-
Mean		0.03	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Standard deviation		0.05	0.00	0.04	0.01	-	0.00	0.00	0.00	0.00	0.01	0.00	-

Table 9-51 Eider EOWDC flight heights (1.02%)

Stage B - rotor transits			**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors			1	0	2	1	0	0	0	0	0	1	0	0	4	**-**
Stage C - risk for single rotor transit																
Collision risk for single rotor transit	(from sheet 3)	5.1%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time																
Collisions assuming no avoidance	birds per month or year		0	0	0	0	0	0	0	0	0	0	0	0	0	
																Error margin
Collisions after applying large array correction		95.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.01**
		98.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.00**
		99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.00**
		99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.00**

Table 9-52 Eider collision risk assessment applying generic proportion at rotor height (2.03%)(Cook *et al*., 2011)

Stage B - rotor transits			**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors			28	0	31	11	0	0	0	0	0	10	0	0	80	-
Stage C - risk for single rotor transit																
Collision risk for single rotor transit		5.1%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time																
Collisions assuming no avoidance	birds per month or year		1	0	1	0	0	0	0	0	0	0	0	0	4	
Stage E - applying avoidance rates																**Error margin**
Collisions after applying large array correction		95.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.19**
		98.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.08**
		99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.04**
		99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.02**

Shag

Table 9-53: Shag Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
	2008 survey 1	0.00	0.00	-	0.00	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.00	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.04	-	0.00	-
	2011 survey 1	0.00	0.00	0.00	0.00	-	0.04	0.05	0.05	-	-		-
	2011 survey 2	-	-	-	-	-	0.22	0.00	0.05	-	0.00	0.05	-
	2012	0.00	-	-	-	-	-	-	-	-	-	-	-
Mean		0.00	0.00	0.00	0.00	0.00	0.09	0.02	0.03	0.02	0.00	0.02	0.00
Standard deviation		0.00	0.00	0.00	0.00	-	0.12	0.03	0.03	0.03	0.00	0.02	-

There were no records of any Shag flying above 25 m in the snapshot counts only generic flight height information has been used to estimate collision risk.

Table 9-54 Shag collision risk assessment applying generic proportion at rotor height (13.11%) (Cook *et al*., 2011)

Stage B - rotor transits			**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors			0	0	0	0	0	504	112	149	81	0	51	0	896	**-**
Stage C - risk for single rotor transit																
Collision risk for single rotor transit	(from sheet 3)	5.5%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time																
Collisions assuming no avoidance	birds per month or year		0	0	0	0	0	23	5	7	4	0	2	0	42	
Stage E - applying avoidance rates																**Error margin**
Collisions after applying large array correction		95.00%	0	0	0	0	0	1	0	0	0	0	0	0	2	**+/- 2.25**
		98.00%	0	0	0	0	0	0	0	0	0	0	0	0	1	**+/- 0.90**
		99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/-0.45**
		99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.22**

Cormorant

Table 9-55: Cormorant Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.02	0.02
	2008 survey 1	0.00	0.00	-	0.00	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.02	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.09	-	0.00	-
	2011 survey 1	0.05	0.00	0.00	0.00	-	0.00	0.09	0.00	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.09	0.09	0.10	-	0.00	0.00	-
	2012	0.05	-	-	-	-	-	-	-	-	-	-	-
Mean		0.03	0.01	0.00	0.01	0.00	0.03	0.06	0.03	0.05	0.00	0.01	0.02
Standard deviation		0.03	0.01	0.00	0.01	-	0.05	0.05	0.06	0.05	0.00	0.01	-

Collision risk assessments were calculated using EOWDC data on the proportion at collision height, it was not possible to find a generic value for proportion at collision risk height. Cook *et al*., (2011) noted that Cormorants were found to be highly variable in offshore areas and models generated to establish flight heights of cormorants recorded in offshore surveys were unable to produce a mean estimate. Previous investigations of cormorant flight heights estimated a relatively low mean height of 8.3 m (range 1 – 150 m) within a relatively wide range (Walls *et al.* 2004; Parnell *et al.* 2005; Petersen *et al.* 2005).

Table 9-56 Cormorant EOWDC flight heights (1.88%)

Stage B - rotor transits		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	-
Potential bird transits through rotors		10	4	0	6	0	24	48	21	29	0	4	6	151	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	6.0%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		1	0	0	0	0	1	2	1	1	0	0	0	8	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.42**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.17**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.08**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.04**

Northern Gannet

Table 9-57: Northern Gannet Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.05	0.00	0.02	0.07	0.07	0.07	0.16	0.05	0.16	0.00	0.00
	2008 survey 1	0.00	0.00	-	0.09	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.00	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.52	-	0.00	-
	2011 survey 1	0.00	0.00	0.00	0.00	-	0.54	0.60	0.38	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.40	0.33	0.63	-	2.06	0.10	-
	2012	0.00	-	-	-	-	-	-	-	-	-	-	-
Mean		0.00	0.02	0.00	0.03	0.07	0.34	0.33	0.39	0.29	1.11	0.03	0.00
Standard deviation		0.00	0.03	0.00	0.04	-	0.24	0.26	0.23	0.33	1.34	0.06	-

Table 9-58 Gannet EOWDC flight heights (8.55%)

Stage B - rotor transits		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	-
Potential bird transits through rotors		0	48	0	99	264	1305	1281	1394	901	3145	72	0	8510	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	6.2%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance	birds per month or year	0	3	0	5	14	69	67	74	48	172	4	0	455	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	0	0	0	0	1	3	3	4	2	9	0	0	23	**+/- 26.83**
	98.00%	0	0	0	0	0	1	1	1	1	3	0	0	9	**+/- 10.74**
	99.00%	0	0	0	0	0	1	1	1	0	2	0	0	5	**+/-5.37**
	99.50%	0	0	0	0	0	0	0	0	0	1	0	0	2	**+/- 2.68**

Table 9-59 Gannet collision risk assessment applying generic proportion at rotor height (15.77%) (Cook *et al*., 2011)

Stage B - rotor transits			**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors			0	89	0	183	486	2407	2362	2572	1661	5801	133	0	15695	-
Stage C - risk for single rotor transit																
Collision risk for single rotor transit		6.2%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time																
Collisions assuming no avoidance	birds per month or year		0	5	0	10	25	127	123	136	89	317	7	0	839	
Stage E - applying avoidance rates																**Error margin**
Collisions after applying large array correction		95.00 %	0	0	0	0	1	6	6	7	4	16	0	0	42	**+/- 49.49**
		98.00 %	0	0	0	0	1	3	2	3	2	6	0	0	17	**+/- 19.80**
		99.00 %	0	0	0	0	0	1	1	1	1	3	0	0	8	**+/- 9.90**
		99.50 %	0	0	0	0	0	1	1	1	0	2	0	0	4	**+/- 4.95**

Red throated diver

Table 9-60: Red throated Diver Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.00	0.02	0.02	0.02	0.00	0.00	0.00	0.05	0.00	0.00	0.05
	2008 survey 1	0.00	0.00	-	0.00	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.00	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.00	-	0.00	-
	2011 survey 1	0.09	0.00	0.00	0.00	-	0.22	0.00	0.00	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.04	0.00	0.00	-	0.04	0.00	-
	2012	0.28	-	-	-	-	-	-	-	-	-	-	-
Mean		0.12	0.00	0.01	0.01	0.02	0.09	0.00	0.00	0.03	0.02	0.00	0.05
Standard deviation		0.14	0.00	0.01	0.01	-	0.12	0.00	0.00	0.04	0.03	0.00	-

Table 9-61 Red throated diver EOWDC flight heights (4.71%)

Stage B - rotor transits		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	-
Potential bird transits through rotors		126	0	17	19	47	219	0	0	53	29	0	48	557	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	5.2%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance	birds per month or year	6	0	1	1	2	10	0	0	2	1	0	2	25	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	1	**+/- 1.76**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.70**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.35**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.18**

Table 9-62 Red throated diver collision risk assessment applying generic proportion at rotor height (3.21%) (Cook *et al*., 2011)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		86	0	11	13	32	149	0	0	36	20	0	33	380	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	5.2%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		4	0	1	1	1	7	0	0	2	1	0	2	17	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	1	**+/- 1.20**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.48**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.24**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.12**

Arctic skua

Table 9-63: Arctic Skua Phase 1 and Phase 2 flight densities

		January	February	March	April	May	June	July	August	September	October	November	December
Phase 1	**2007**	-	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
	2008 survey 1	0.00	0.00	-	0.00	-	-	-	-	-	-	-	-
	2008 survey 2	-	-	-	0.00	-	-	-	-	-	-	-	-
Phase 2	**2010**	-	-	-	-	-	-	-	-	0.04	-	0.00	-
	2011 survey 1	0.00	0.00	0.00	0.00	-	0.00	0.05	0.00	-	-	-	-
	2011 survey 2	-	-	-	-	-	0.00	0.00	0.05	-	0.00	0.00	-
	2012	0.00	-	-	-	-	-	-	-	-	-	-	-
Mean		0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.00	0.00	0.00
Standard deviation		0.00	0.00	0.00	0.00	-	0.00	0.02	0.03	0.03	0.00	0.00	-

Table 9-64 Arctic Skua EOWDC flight heights (16.07%)

Stage B - rotor transits		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per annum	-
Potential bird transits through rotors		0	0	0	0	0	0	107	90	67	0	0	0	264	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	5.9%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		0	0	0	0	0	0	5	5	3	0	0	0	13	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	1	**+/- 1.06**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.42**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.21**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.11**

Table 9-65 Arctic Skua diver collision risk assessment applying generic proportion at rotor height (3.30%) (Cook *et al*., 2011)

Stage B - rotor transits		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**per annum**	**-**
Potential bird transits through rotors		0	0	0	0	0	0	22	18	14	0	0	0	54	-
Stage C - risk for single rotor transit															
Collision risk for single rotor transit	5.9%														
Stage D - multiplying up for entire windfarm and allowing for non-operational time															
Collisions assuming no avoidance birds per month or year		0	0	0	0	0	0	1	1	1	0	0	0	3	
Stage E - applying avoidance rates															**Error margin**
Collisions after applying large array correction	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.14**
	98.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.10**
	99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.02**
	99.50%	0	0	0	0	0	0	0	0	0	0	0	0	0	**+/- 0.02**

9.10 Summary of collision risk model based on revised Rochdale.

Table 9-66 Summary results of collision risk model applying a range of avoidance rates and EOWDC and Cook *et al*., (2011) proportion at rotor height

Species Name	Collision risk assessment applying EOWDC proportion at collision risk height				Collision risk assessment applying Cook *et al*., (2011) proportion at collision risk height			
	95%	98%	99%	99.5%	95%	98%	99%	99.5%
Guillemot	1 +/- 1.49	0 +/- 0.60	0 +/-0.30	0 +/- 0.15	8 +/- 10.10	3 +/- 4.04	2 +/- 2.02	1 +/- 1.01
Razorbill	1 +/- 0.10	0 +/-0.04	0 +/-0.02	0 +/-0.01	3 +/- 3.77	1 +/- 1.51	0 +/- 0.75	0 +/- 0.38
Puffin	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00
Fulmar	1 +/- 0.78	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	5 +/- 3.90	2 +/- 1.56	1 +/- 0.78	0 +/- 0
Common tern	0 +/- 0.76	0 +/- 0.30	0 +/- 0.15	0 +/- 0.08	1 +/- 2.27	1 +/- 0.91	0 +/- 0.45	0 +/- 0.23
Sandwich tern	1 +/- 0.89	0 +/- 0.36	0 +/- 0.18	0 +/- 0.09	1 +/- 0.80	0 +/- 0.32	0 +/- 0.16	0 +/- 0.08
Herring gull	48 +/- 48.02	19 +/- 19.02	10 +/- 9.61	5 +/- 4.80	49 +/- 46.26	19 +/- 18.51	9 +/- 9.26	5 +/- 4.63
Black-legged kittiwake	86 +/- 69.64	34 +/- 27.86	17 +/- 13.93	9 +/- 6.97	74 +/- 60.22	30 +/- 24.99	15 +/- 12.05	7 +/- 6.02
Grt black-backed gull	30 +/- 44.58	12 +/- 17.84	6 +/- 8.92	3 +/- 4.46	25 +/- 37.69	10 +/- 15.08	5 +/- 7.54	3 +/- 3.77
Common gull	51 +/- 71.58	20 +/- 28.64	10 +/- 14.32	5 +/- 7.16	37 +/- 52.82	15 +/- 21.13	7 +/- 10.57	4 +/- 5.28
Common scoter	0 +/- 0.03	0 +/- 0.01	0 +/- 0.01	0 +/- 0.00	0 +/- 0.58	0 +/- 0.23	0 +/-0.12	0 +/- 0.06
Eider	0 +/- 0.01	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	0 +/- 0.19	0 +/- 0.08	0 +/- 0.04	0 +/- 0.02
Shag	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	0 +/- 0.00	2 +/- 2.25	1 +/- 0.90	0 +/-0.45	0 +/- 0.22
Cormorant	0 +/- 0.42	0 +/- 0.17	0 +/- 0.08	0 +/- 0.04	x	x	x	x
Northern Gannet	23 +/- 26.83	9 +/- 10.74	5 +/-5.37	2 +/- 2.68	42 +/- 49.49	17 +/- 19.80	8 +/- 9.90	4 +/- 4.95
Red throated diver	1 +/- 1.76	0 +/- 0.70	0 +/- 0.35	0 +/- 0.18	1 +/- 1.20	0 +/- 0.48	0 +/- 0.24	0 +/- 0.12
Arctic Skua	1 +/- 1.06	0 +/- 0.42	0 +/- 0.21	0 +/- 0.11	1 +/- 0.14	0 +/- 0.10	0 +/- 0.02	0 +/- 0.02

Appendix 9A: Monthly Bird Densities derived from Phase 1 and Phase 2 surveys

Monthly bird densities derived from Phase 1 and Phase 2 surveys are presented in Table 8-66 to Table 8-101.

Table 9-67: Guillemot snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	1	-	-	-	-	-	-	1	0.02
2	March	2007	3	-	-	-	-	-	-	3	0.07
3	April	2007	2	2	-	-	-	-	-	4	0.09
4	May	2007	1	1	-	-	-	-	-	2	0.05
5	June	2007	4	-	-	-	-	-	-	4	0.09
6	July	2007	-	-	-	-	-	-	-	0	0
7	August	2007	-	-	-	-	-	-	-	0	0
8	September	2007	-	-	-	-	-	-	-	0	0
9	October	2007	1	1	-	-	-	-	-	2	0.05
10	November	2007	1	-	-	-	-	-	-	1	0.02
11	December	2007	-	-	-	-	-	-	-	0	0
12	January	2008	-	-	-	-	-	-	-	0	0
13	February	2008	-	-	-	-	-	-	-	0	0
14	April	2008	1	-	-	-	-	-	-	1	0.02
15	April	2008	1	-	-	-	-	-	-	1	0.02
	Total		15	4	-	-	-	-	-	19	0.02

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Table 9-68 Guillemot snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	7	-	-	-	-	-	7	0.32
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	23	2	-	-	-	-	-	25	1.12
6	June_2	2011	37	4	-	-	-	-	-	41	1.84
7	July_1	2011	6	1	2	-	-	-	-	9	0.41
8	July_2	2011	-	1	2	-	-	-	-	3	0.14
9	August_1	2010	-	-	-	-	-	-	-	0	0.00
10	August_2	2011	-	-	-	-	-	-	-	0	0.00
11	September	2010	-	-	-	-	-	-	-	0	0.00
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	9	1	-	1	-	-	-	11	0.49
14	November	2011	14	3	-	-	-	-	-	17	0.82
15	January	2012	10	1	-	-	-	-	-	11	0.51
	Total	-	99	20	4	1	-	-	-	124	-

Table 9-69: Razorbill snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	-	-	-	-	-	0	0
2	March	2007	-	1	-	-	-	-	-	1	0.02
3	April	2007	-	1	-	-	-	-	-	1	0.02
4	May	2007	2	-	-	-	-	-	-	2	0.05
5	June	2007	-	-	-	-	-	-	-	0	0
6	July	2007	-	-	-	-	-	-	-	0	0
7	August	2007	-	-	-	-	-	-	-	0	0
8	September	2007	-	-	-	-	-	-	-	0	0
9	October	2007	1	-	-	-	-	-	-	1	0.02
10	November	2007	-	-	-	-	-	-	-	0	0
11	December	2007	-	-	-	-	-	-	-	0	0
12	January	2008	-	-	-	-	-	-	-	0	0
13	February	2008	1	-	-	-	-	-	-	1	0.02
14	April	2008	3	2	-	-	-	-	-	5	0.11
15	April	2008	5	-	-	-	-	-	-	5	0.11
	Total		12	4	-	-	-	-	-	16	-

Table 9-70 Razorbill snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	6	-	-	-	-	-	-	6	0.27
6	June_2	2011	9	1	-	-	-	-	-	10	0.45
7	July_1	2011	1	1	-	-	-	-	-	2	0.09
8	July_2	2011	-	4	1	-	-	-	-	5	0.23
9	August_1	2010	-	-	-	-	-	-	-	0	0.00
10	August_2	2011	-	-	-	-	-	-	-	0	0.00
11	September	2010	-	-	-	-	-	-	-	0	0.00
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	1	-	-	-	-	-	-	1	0.04
14	November	2011	-	-	-	-	-	-	-	0	0.00
15	January	2012	2	-	-	-	-	-	-	2	0.09
	Total	-	19	6	1	-	-	-	-	26	-

Table 9-71: Puffin snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	-	-	-	-	-	0	0.00
2	March	2007	-	-	-	-	-	-	-	0	0.00
3	April	2007	-	-	-	-	-	-	-	0	0.00
4	May	2007	-	-	-	-	-	-	-	0	0.00
5	June	2007	-	2	-	-	-	-	-	2	0.05
6	July	2007	-	-	-	-	-	-	-	0	0.00
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	-	-	-	-	-	-	-	0	0.00
9	October	2007	-	-	-	-	-	-	-	0	0.00
10	November	2007	-	-	-	-	-	-	-	0	0.00
11	December	2007	-	-	-	-	-	-	-	0	0.00
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	-	-	-	-	-	-	-	0	0.00
15	April	2008	-	-	-	-	-	-	-	0	0.00
	Total		-	2	-	-	-	-	-	2	-

Table 9-72 Puffin snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	3	1	-	-	-	-	-	4	0.18
6	June_2	2011	2	-	-	-	-	-	-	2	0.09
7	July_1	2011	1	1	-	-	-	-	-	2	0.09
8	July_2	2011	-	2	-	-	-	-	-	2	0.09
9	August_1	2010	1	-	-	-	-	-	-	1	0.05
10	August_2	2011	-	-	-	-	-	-	-	0	0.00
11	September	2010	-	-	-	-	-	-	-	0	0.00
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	-	-	-	-	-	-	0	0.00
14	November	2011	-	-	-	-	-	-	-	0	0.00
15	January	2012	-	-	-	-	-	-	-	0	0.00
	Total	-	7	4	-	-	-	-	-	11	-

Table 9-73: Northern Fulmar snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	7	1	-	-	-	-	-	8	0.18
2	March	2007	1	-	-	-	-	-	-	1	0.02
3	April	2007	-	1	-	-	-	-	-	1	0.02
4	May	2007	4	1	-	-	-	-	-	5	0.11
5	June	2007	5	1	-	-	-	-	-	6	0.14
6	July	2007	1	1	-	-	-	-	-	2	0.05
7	August	2007	1	-	-	-	-	-	-	1	0.02
8	September	2007	-	1	-	-	-	-	-	1	0.02
9	October	2007	-	-	-	-	-	-	-	0	0.00
10	November	2007	-	-	-	-	-	-	-	0	0.00
11	December	2007	-	2	2	-	-	-	-	4	0.09
12	January	2008	3	-	-	-	-	-	-	3	0.07
13	February	2008	1	-	-	-	-	-	-	1	0.02
14	April	2008	5	1	-	-	-	-	-	6	0.14
15	April	2008	3	4	-	-	-	-	-	7	0.16
-	**Total**	-	31	13	2	-	-	-	-	46	-

Table 9-74 Northern Fulmar snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	1	-	-	-	-	-	1	0.05
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	3	2	-	-	-	-	-	5	0.22
6	June_2	2011	-	1	-	-	-	-	-	1	0.04
7	July_1	2011	3	1	-	-	-	-	-	4	0.18
8	July_2	2011	-	3	-	-	-	-	-	3	0.14
9	August_1	2010	3	1	-	-	-	-	-	4	0.19
10	August_2	2011	1	2	-	-	-	-	-	3	0.14
11	September	2010	7	1	-	-	-	-	-	8	0.35
12	November	2010	-	-	-	-	-	-	-	3	0.13
13	October	2011	-	-	-	-	-	-	-	0	0.00
14	November	2011	2	-	1	-	-	-	-	3	0.14
15	January	2012	2	-	-	-	-	-	-	2	0.09
	Total	-	21	12	1	-	-	-	-	34	-

Table 9-75: Common tern snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	-	-	-	-	-	0	0.00
2	March	2007	-	-	-	-	-	-	-	0	0.00
3	April	2007	-	-	-	-	-	-	-	0	0.00
4	May	2007	1	-	-	-	-	-	-	1	0.02
5	June	2007	-	1	-	-	-	-	-	1	0.02
6	July	2007	-	-	1	-	-	-	-	1	0.02
7	August	2007	-	-	2	-	-	-	-	2	0.05
8	September	2007	-	-	-	-	-	-	-	0	0.00
9	October	2007	-	-	-	-	-	-	-	0	0.00
10	November	2007	-	-	-	-	-	-	-	0	0.00
11	December	2007	-	-	-	-	-	-	-	0	0.00
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	-	-	-	-	-	-	-	0	0.00
15	April	2008	-	-	-	-	-	-	-	0	0.00
	Total		1	1	3	-	-	-	-	5	-

Table 9-76 Common tern snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	-	1	-	-	-	-	-	1	0.04
6	June_2	2011	-	1	-	-	-	-	-	1	0.04
7	July_1	2011	1	2	4	1	-	-	-	8	0.37
8	July_2	2011	-	-	-	-	-	-	-	0	0.00
9	August_1	2010	-	3	-	-	-	-	-	3	0.14
10	August_2	2011	-	1	-	-	-	-	-	1	0.05
11	September	2010	-	1	-	-	-	-	-	1	0.04
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	-	-	-	-	-	-	0	0.00
14	November	2011	-	-	-	-	-	-	-	0	0.00
15	January	2012	-	-	-	-	-	-	-	0	0.00
	Total	-	1	9	4	1	-	-	-	15	-

Table 9-77: Sandwich tern snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	-	-	-	-	-	0	0.00
2	March	2007	-	-	-	-	-	-	-	0	0.00
3	April	2007	-	-	-	-	-	-	-	0	0.00
4	May	2007	1	1	1	-	-	-	-	3	0.07
5	June	2007	-	3	-	-	-	-	-	3	0.07
6	July	2007	-	-	-	-	-	-	-	0	0.00
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	-	-	-	-	-	-	-	0	0.00
9	October	2007	-	-	-	-	-	-	-	0	0.00
10	November	2007	-	-	-	-	-	-	-	0	0.00
11	December	2007	-	-	-	-	-	-	-	0	0.00
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	-	-	-	-	-	-	-	0	0.00
15	April	2008	-	1	1	-	-	-	-	2	0.05
	Total		1	5	2	-	-	-	-	8	-

Table 9-78 Sandwich tern snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	-	-	-	-	-	-	-	0	0.00
6	June_2	2011	-	1	-	-	-	-	-	1	0.04
7	July_1	2011	1	1	-	-	-	-	-	2	0.09
8	July_2	2011	-	-	-	-	-	-	-	0	0.00
9	August_1	2010	-	-	-	-	-	-	-	0	0.00
10	August_2	2011	-	-	-	-	-	-	-	0	0.00
11	September	2010	-	1	-	-	-	-	-	1	0.04
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	-	-	-	-	-	-	0	0.00
14	November	2011	-	-	-	-	-	-	-	0	0.00
15	January	2012	-	-	-	-	-	-	-	0	0.00
	Total	-	1	2	-	-	-	-	-	4	-

Table 9-79: Herring gull snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	1	-	-	-	-	1	0.02
2	March	2007	-	-	3	-	-	-	-	3	0.07
3	April	2007	-	-	-	-	-	-	-	0	0.00
4	May	2007	-	-	-	-	-	-	-	0	0.00
5	June	2007	-	-	1	1	-	-	-	2	0.05
6	July	2007	-	-	1	-	2	-	-	3	0.07
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	-	-	-	-	-	-	-	0	0.00
9	October	2007	-	-		1	-	-	-	1	0.02
10	November	2007	-	-	2	4	-	-	-	6	0.14
11	December	2007	-	-	1	-	-	-	-	1	0.02
12	January	2008	-	-	2	-	-	-	-	2	0.05
13	February	2008	-	-	2	-	-	2	-	4	0.09
14	April	2008	-	-	1	1	-	-	-	2	0.05
15	April	2008	-	-	2	1	1	-	-	4	0.09
	Total		-	-	16	8	3	2	-	29	-

Table 9-80 Herring gull snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	1	6	8	2	1	-	18	0.82
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	3	5	8	3	-	-	-	19	0.85
6	June_2	2011	2	1	4	8	2	-	-	17	0.76
7	July_1	2011	-	-	2	9	-	-	-	11	0.51
8	July_2	2011	-	-	2	1	1	-	-	4	0.19
9	August_1	2010	-	-	2	1	-	-	-	3	0.14
10	August_2	2011	1	-	-	-	-	-	-	1	0.05
11	September	2010	-	-	-	-	-	-	-	0	0.00
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	2	-	1	-	-	-	3	0.13
14	November	2011	1	1	8	11	-	-	-	21	1.01
15	January	2012	-	-	2	1	-	-	-	3	0.14
	Total	-	7	10	34	43	5	1	-	100	-

Table 9-81: Black legged kittiwake snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	1	-	-	-	-	1	0.02
2	March	2007	-	-	-	-	-	-	-	0	0.00
3	April	2007	-	5	2	-	-	-	-	7	0.16
4	May	2007	2	4	10	-	-	-	-	16	0.36
5	June	2007	3	4	8	-	1	-	-	16	0.36
6	July	2007	-	-	7	1		-	-	8	0.18
7	August	2007	-	-	5	6	1	-	-	12	0.27
8	September	2007	-	-	1	2		-	-	3	0.07
9	October	2007	-	-	-	-	-	-	-	0	0.00
10	November	2007	-	-	-	-	-	-	-	0	0.00
11	December	2007	-	-	-	-	-	-	-	0	0.00
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	2	1	5					7	0.16
15	April	2008	2	-	11	3				16	0.36
	Total	-	9	14	50	12	2	-	-	87	-

Table 9-82 Black legged kittiwake snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	2	-	-	-	-	2	0.09
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	9	30	3	-	-	-	-	42	1.88
6	June_2	2011	9	22	16	4	-	-	-	51	2.29
7	July_1	2011	3	10	23	5	-	-	-	41	1.89
8	July_2	2011	1	6	19	13	-	-	-	44	2.05
9	August_1	2010	3	2	4	2	-	-	-	11	0.52
10	August_2	2011	1	4	16	3	-	-	-	24	1.15
11	September	2010	-	10	-	-	-	-	-	10	0.44
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	2	14	10	-	-	-	26	1.16
14	November	2011	-	1	3	4	-	-	-	8	0.39
15	January	2012	-	-	4	2	-	-	-	6	0.28
	Total	-	26	87	104	43	-	-	-	265	-

Table 9-83: Great Black Back Gull snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	-	-	-	-	-	0	0.00
2	March	2007	-	-	-	1	-	-	-	1	0.02
3	April	2007	-	-	1	-	-	-	-	1	0.02
4	May	2007	-	-	-	-	-	-	-	0	0.00
5	June	2007	-	-	-	-	-	-	-	0	0.00
6	July	2007	-	-	-	-	-	-	-	0	0.00
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	-	-	-	-	-	-	-	0	0.00
9	October	2007	-	-	-	-	-	1	-	1	0.02
10	November	2007	-	-	1	1	-	-	-	2	0.05
11	December	2007	-	-	3	2	-	-	-	5	0.11
12	January	2008	-	1	3	1	-	-	-	5	0.11
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	-	-	-	-	1	-	-	1	0.02
15	April	2008	-	-	-	-	-	-	-	0	0.00
	Total		-	1	8	5	1	1	-	16	-

Table 9-84 Great black backed gull snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	1	-	-	-	-	1	0.05
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	-	1	-	-	-	-	-	1	0.04
6	June_2	2011	-	1	-	-	-	-	-	1	0.04
7	July_1	2011	-	-	-	-	-	-	-	0	0.00
8	July_2	2011	-	-	-	-	-	-	-	0	0.00
9	August_1	2010	-	-	2	-	-	-	-	2	0.09
10	August_2	2011	2	1	1	1				5	0.24
11	September	2010	-	-	-	-	-	-	-	0	0.00
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	3	2	9	2				16	0.72
14	November	2011	2	1	-	-	-	-	-	3	0.14
15	January	2012	-	1	2	-	-	-	-	3	0.14
	Total	-	7	7	15	3	-	-	-	32	-

Table 9-85: Common Gull snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	2	7	-	-	-	-	9	0.20
2	March	2007	-	-	2	-	-	-	-	2	0.05
3	April	2007	-	-	2	2	-	-	-	4	0.09
4	May	2007	-	-	-	1	-	-	-	1	0.02
5	June	2007	-	-	-	-	-	-	-	0	0.00
6	July	2007	-	-	-	-	-	-	-	0	0.00
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	-	-	1	-	-	-	-	1	0.02
9	October	2007	-	-	8	3	-	-	-	11	0.25
10	November	2007	-	-	5	6	-	-	-	11	0.25
11	December	2007	-	-	5	2	-	-	-	7	0.16
12	January	2008	-	-	4	3	-	-	-	7	0.16
13	February	2008	-	-	5	4	-	-	-	9	0.20
14	April	2008	-	-	1	-	-	-	-	1	0.02
15	April	2008	1	-	-	-	-	-	-	1	0.02
	Total		1	2	40	21	-	-	-	64	

Table 9-86 Common gull snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	4	4	1	1	-	10	0.45
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	1	1	-	-	-	-	-	2	0.09
6	June_2	2011	-	-	-	-	-	-	-	0	0.00
7	July_1	2011	-	-	1	-	-	-	-	1	0.05
8	July_2	2011	-	-	-	-	-	-	-	0	0.00
9	August_1	2010	-	-	-	-	-	-	-	0	0.00
10	August_2	2011	-	-	-	-	-	-	-	0	0.00
11	September	2010	-	-	-	-	-	-	-	0	0.00
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	1	8	27	8	-	-	-	45	2.02
14	November	2011	-	1	1	-	-	-	-	2	0.10
15	January	2012	1	1	3	2	-	-	-	7	0.32
	Total	-	3	11	36	15	1	1	-	66	-

Table 9-87: Common scoter snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	-	-	-	-	-	0	0.00
2	March	2007	-	-	-	-	-	-	-	0	0.00
3	April	2007	-	-	-	-	-	-	-	0	0.00
4	May	2007	-	-	-	-	-	-	-	0	0.00
5	June	2007	-	-	-	-	-	-	-	0	0.00
6	July	2007	-	-	-	-	-	-	-	0	0.00
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	-	-	-	-	-	-	-	0	0.00
9	October	2007	-	1	-	-	-	-	-	1	0.02
10	November	2007	1	-	-	-	-	-	-	1	0.02
11	December	2007	-	-	-	-	-	-	-	0	0.00
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	-	-	-	-	-	-	-	0	0.00
15	April	2008	-	-	-	-	-	-	-	0	0.00
	Total		1	1	-	-	-	-	-	2	-

Table 9-88 Common scoter snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	-	-	-	-	-	-	-	0	0.00
6	June_2	2011	-	-	-	-	-	-	-	0	0.00
7	July_1	2011	-	-	1	-	-	-	-	1	0.05
8	July_2	2011	-	-	-	-	-	-	-	0	0.00
9	August_1	2010	-	-	-	-	-	-	-	0	0.00
10	August_2	2011	-	-	-	-	-	-	-	0	0.00
11	September	2010	1	-	-	-	-	-	-	1	0.04
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	-	1	-	-	-	-	1	0.04
14	November	2011	-	-	-	-	-	-	-	0	0.00
15	January	2012	-	-	-	-	-	-	-	0	0.00
	Total	-	1	-	2	-	-	-	-	3	-

Table 9-89: Eider snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	-	-	-	-	-	0	0.00
2	March	2007	2	-	-	-	-	-	-	2	0.05
3	April	2007	-	-	-	-	-	-	-	0	0.00
4	May	2007	-	-	-	-	-	-	-	0	0.00
5	June	2007	-	-	-	-	-	-	-	0	0.00
6	July	2007	-	-	-	-	-	-	-	0	0.00
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	-	-	-	-	-	-	-	0	0.00
9	October	2007	-	-	1	-	-	-	-	1	0.02
10	November	2007	-	-	-	-	-	-	-	0	0.00
11	December	2007	-	-	-	-	-	-	-	0	0.00
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	-	-	-	-	-	-	-	0	0.00
15	April	2008	1	-	-	-	-	-	-	1	0.02
	Total		3	-	1	-	-	-	-	4	-

Table 9-90 Eider snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	-	-	-	-	-	-	-	0	0.00
6	June_2	2011	-	-	-	-	-	-	-	0	0.00
7	July_1	2011	-	-	-	-	-	-	-	0	0.00
8	July_2	2011	-	-	-	-	-	-	-	0	0.00
9	August_1	2010	-	-	-	-	-	-	-	0	0.00
10	August_2	2011	-	-	-	-	-	-	-	0	0.00
11	September	2010	-	-	-	-	-	-	-	0	0.00
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	-	-	-	-	-	-	0	0.00
14	November	2011	-	-	-	-	-	-	-	0	0.00
15	January	2012	2	-	-	-	-	-	-	2	0.09
	Total	-	2	-	-	-	-	-	-	2	-

Table 9-91: Shag snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	-	-	-	-	-	0	0.00
2	March	2007	-	-	-	-	-	-	-	0	0.00
3	April	2007	-	-	-	-	-	-	-	0	0.00
4	May	2007	-	-	-	-	-	-	-	0	0.00
5	June	2007	-	-	-	-	-	-	-	0	0.00
6	July	2007	-	-	-	-	-	-	-	0	0.00
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	-	-	-	-	-	-	-	0	0.00
9	October	2007	-	-	-	-	-	-	-	0	0.00
10	November	2007	-	1	-	-	-	-	-	1	0.02
11	December	2007	-	-	-	-	-	-	-	0	0.00
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	-	-	-	-	-	-	-	0	0.00
15	April	2008	-	-	-	-	-	-	-	0	0.00
	Total		-	1	-	-	-	-	-	1	-

Table 9-92 Shag snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	1	-	-	-	-	-	-	1	0.04
6	June_2	2011	5	-	-	-	-	-	-	5	0.22
7	July_1	2011	1	-	-	-	-	-	-	1	0.05
8	July_2	2011	-	-	-	-	-	-	-	0	0.00
9	August_1	2010	1	-	-	-	-	-	-	1	0.05
10	August_2	2011	1	-	-	-	-	-	-	1	0.05
11	September	2010	1	-	-	-	-	-	-	1	0.04
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	-	-	-	-	-	-	0	0.00
14	November	2011	1	-	-	-	-	-	-	1	0.05
15	January	2012		-	-	-	-	-	-	0	0.00
	Total	-	11	-	-	-	-	-	-	11	-

Table 9-93: Cormorant snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	1	-	-	-	-	-	-	1	0.02
2	March	2007	-	-	-	-	-	-	-	0	0.00
3	April	2007	-	-	-	-	-	-	-	0	0.00
4	May	2007	-	-	-	-	-	-	-	0	0.00
5	June	2007	-	-	-	-	-	-	-	0	0.00
6	July	2007	-	-	-	-	-	-	-	0	0.00
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	1	-	-	-	-	-	-	1	0.02
9	October	2007	-	-	-	-	-	-	-	0	0.00
10	November	2007	-	1	-	-	-	-	-	1	0.02
11	December	2007	-	-	1	-	-	-	-	1	0.02
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	-	-	-	-	-	-	-	0	0.00
15	April	2008	1	-	-	-	-	-	-	1	0.02
	Total		3	1	1	-	-	-	-	5	-

Table 9-94 Cormorant snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	1	-	-	-	-	-	1	0.05
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	-	-	-	-	-	-	-	0	0.00
6	June_2	2011	1	-	1	-	-	-	-	2	0.09
7	July_1	2011	-	1	-	1	-	-	-	2	0.09
8	July_2	2011	-	2	-	-	-	-	-	2	0.09
9	August_1	2010	-	-	-	-	-	-	-	0	0.00
10	August_2	2011	2	-	-	-	-	-	-	2	0.10
11	September	2010	2	-	-	-	-	-	-	2	0.09
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	-	-	-	-	-	-	0	0.00
14	November	2011	-	-	-	-	-	-	-	0	0.00
15	January	2012	1	-	-	-	-	-	-	1	0.05
	Total	-	6	4	1	1	-	-	-	12	-

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Table 9-95: Northern Gannet snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	1	-	1	-	-	-	-	2	0.05
2	March	2007	-	-	-	-	-	-	-	0	0.00
3	April	2007	-	1	-	-	-	-	-	1	0.02
4	May	2007	1	1	1	-	-	-	-	3	0.07
5	June	2007	-	2	-	1	-	-	-	3	0.07
6	July	2007	1	1	1		-	-	-	3	0.07
7	August	2007	1	2	3	1	-	-	-	7	0.16
8	September	2007	1	1	-	-	-	-	-	2	0.05
9	October	2007	-	2	5	-	-	-	-	7	0.16
10	November	2007	-	-	-	-	-	-	-	0	0.00
11	December	2007	-	-	-	-	-	-	-	0	0.00
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	1	2	1	-	-	-	-	4	0.09
15	April	2008	-	-	-	-	-	-	-	0	0.00
	Total		6	12	12	2	-	-	-	32	-

Table 9-96 Northern Gannet snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	2	5	5	-	-	-	-	12	0.54
6	June_2	2011	4	3	-	2	-	-	-	9	0.40
7	July_1	2011	5	4	4		-	-	-	13	0.60
8	July_2	2011	1	2	2	2	-	-	-	7	0.33
9	August_1	2010	2	2	3	1	-	-	-	8	0.38
10	August_2	2011	1	8	4	-	-	-	-	13	0.63
11	September	2010	3	3	6	-	-	-	-	12	0.52
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	17	14	15	-	-	-	-	46	2.06
14	November	2011	2	-	-	-	-	-	-	2	0.10
15	January	2012	-	-	-	-	-	-	-	0	0.00
	Total	-	37	41	39	5	-	-	-	122	-

Table 9-97: Red-Throated Diver snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	-	-	-	-	-	0	0.00
2	March	2007	1	-	-	-	-	-	-	1	0.02
3	April	2007	-	-	1	-	-	-	-	1	0.02
4	May	2007	-	-	1	-	-	-	-	1	0.02
5	June	2007	-	-	-	-	-	-	-	0	0.00
6	July	2007	-	-	-	-	-	-	-	0	0.00
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	2	-	-	-	-	-	-	2	0.05
9	October	2007	-	-	-	-	-	-	-	0	0.00
10	November	2007	-	-	-	-	-	-	-	0	0.00
11	December	2007	-	-	2	-	-	-	-	2	0.05
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	-	-	-	-	-	-	-	0	0.00
15	April	2008	-	-	-	-	-	-	-	0	0.00
	Total		3	-	4	-	-	-	-	7	-

Table 9-98 Red throated diver snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	1	1	-	-	-	-	2	0.09
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	2	3	-	-	-	-	-	5	0.22
6	June_2	2011	-	1	-	-	-	-	-	1	0.04
7	July_1	2011	-	-	-	-	-	-	-	0	0.00
8	July_2	2011	-	-	-	-	-	-	-	0	0.00
9	August_1	2010	-	-	-	-	-	-	-	0	0.00
10	August_2	2011	-	-	-	-	-	-	-	0	0.00
11	September	2010	-	-	-	-	-	-	-	0	0.00
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	-	1	-	-	-	-	1	0.04
14	November	2011	-	-	-	-	-	-	-	0	0.00
15	January	2012	2	1	2	1	-	-	-	6	0.28
	Total	-	4	6	4	1	-	-	-	15	-

Table 9-99: Arctic Skua snapshot counts and bird densities Phase 1 data February 2007-April 2008.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	February	2007	-	-	-	-	-	-	-	0	0.00
2	March	2007	-	-	-	-	-	-	-	0	0.00
3	April	2007	-	-	-	-	-	-	-	0	0.00
4	May	2007	-	-	-	-	-	-	-	0	0.00
5	June	2007	-	-	-	-	-	-	-	0	0.00
6	July	2007	-	-	1	-	-	-	-	1	0.02
7	August	2007	-	-	-	-	-	-	-	0	0.00
8	September	2007	-	-	-	-	-	-	-	0	0.00
9	October	2007	-	-	-	-	-	-	-	0	0.00
10	November	2007	-	-	-	-	-	-	-	0	0.00
11	December	2007	-	-	-	-	-	-	-	0	0.00
12	January	2008	-	-	-	-	-	-	-	0	0.00
13	February	2008	-	-	-	-	-	-	-	0	0.00
14	April	2008	-	-	-	-	-	-	-	0	0.00
15	April	2008	-	-	-	-	-	-	-	0	0.00
	Total		-	-	-	-	-	-	-	1	-

Table 9-100 Arctic Skua snapshot counts, north transect only Phase 2 data August 2010-January 2012.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	-	-	-	-	-	-	-	0	0.00
6	June_2	2011	-	-	-	-	-	-	-	0	0.00
7	July_1	2011	1	-	-	-	-	-	-	1	0.05
8	July_2	2011	-	-	-	-	-	-	-	0	0.00
9	August_1	2010	-	-	-	-	-	-	-	0	0.00
10	August_2	2011	-	-	1	-	-	-	-	1	0.05
11	September	2010	-	1	-	-	-	-	-	1	0.04
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	1	1		1	-	-	-	0	0.00
14	November	2011	-	-	-	-	-	-	-	0	0.00
15	January	2012	-	-	-	-	-	-	-	0	0.00
	Total	-	-	-	-	-	-	-	-	6	-

Table 9-101 Arctic tern snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey number	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Monthly Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	-	3	-	-	-	-	-	3	0.13
6	June_2	2011	2	5	-	-	-	-	-	7	0.31
7	July_1	2011	2	2	4	-	-	-	-	8	0.37
8	July_2	2011	-	2	7	3	-	-	-	12	0.56
9	August_1	2010	2	1	-	-	-	-	-	3	0.14
10	August_2	2011	-	2	1	-	-	-	-	3	0.14
11	September	2010	-	-	-	-	-	-	-	0	0.00
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	-	-	-	-	-	-	-	0	0.00
14	November	2011	-	-	1	-	-	-	-	1	0.05
15	January	2012	-	-	-	-	-	-	-	0	0.00
	Total	-	**6**	**15**	**13**	**3**	**-**	**-**	**-**	**37**	**-**

Table 9-102 Great Skua snapshot counts, north transect only, Phase 2 data August 2010-January 2012.

Survey ID	Month	Year	0-2	2-10	10-25	25-50	50-100	100-200	200+	Grand Total	Bird Density (km^2)
1	January	2011	-	-	-	-	-	-	-	0	0.00
2	February	2011	-	-	-	-	-	-	-	0	0.00
3	March	2011	-	-	-	-	-	-	-	0	0.00
4	April	2011	-	-	-	-	-	-	-	0	0.00
5	June_1	2011	-	-	-	-	-	-	-	0	0.00
6	June_2	2011	-	-	-	-	-	-	-	0	0.00
7	July_1	2011	-	-	-	-	-	-	-	0	0.00
8	July_2	2011	-	-	-	-	-	-	-	0	0.00
9	August_1	2010	-	-	-	-	-	-	-	0	0.00
10	August_2	2011	-	-	-	-	-	-	-	0	0.00
11	September	2010	1	1	-	-	-	-	-	2	0.09
12	November	2010	-	-	-	-	-	-	-	0	0.00
13	October	2011	1	-	-	-	-	-	-	1	0.04
14	November	2011	3	-	-	-	-	-	-	3	0.14
15	January	2012		-	-	-	-	-	-	0	0.00
	Total	-	5	1	-	-	-	-	-	6	-

Table 9-103: Summary of snapshot count used to estimate density of flying birds in Phase 2

Survey ID	Month	Year	Total number of Snapshots	Total area covered by snapshots km^2
1	January	2011	245	22.05
2	February	2011	247	22.23
3	March	2011	250	22.5
4	April	2011	211	18.99
5	June_1	2011	248	22.32
6	June_2	2011	247	22.23
7	July_1	2011	241	21.69
8	July_2	2011	239	21.51
9	August_1	2010	234	21.06
10	August_2	2011	231	20.79
11	September	2010	255	22.95
12	November	2010	254	22.86
13	October	2011	248	22.32
14	November	2011	230	20.7
15	January	2012	240	21.6

Table 9-104: Relative errors produced, note the large standard errors have resulted in the errors being >100% in the majority of species.

Species	Error +/- %
Arctic Skua	159
Arctic Tern	117
Common tern	162
Sandwich tern	147
Common Gull	141
Cormorant	101
Eider	187
Fulmar	78
Gannet	118
Great Black Backed Gull	150
Guillemot	108
Herring Gull	101
Kittiwake	81
Puffin	101
Razorbill	113
Red throated Diver	141
Common Scoter	123
Shag	146

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Alerstam T, Rose´n M, Beckman J, Ericson PGP, Hellgren O (2007) Flight speeds among bird species: Allometric and phylogenetic effects. PLoS Biol 5(8): e197. doi:10.1371/journal.pbio.0050197

Birdlife International (2012). Website: http://seabird.wikispaces.com/Sandwich+Tern Date accessed 8/3/2012.

British Trust for Ornithology, bird fact sheets (2012): Date accessed 8/3/2012.

Species	Website Address
Red throated Diver	http://blx1.bto.org/birdfacts/results/bob20.htm
Gannet	http://blx1.bto.org/birdfacts/results/bob710.htm
Common gull	http://blx1.bto.org/birdfacts/results/bob5900.htm
Black legged Kittiwake	http://blx1.bto.org/birdfacts/results/bob6020.htm
Herring gull	http://blx1.bto.org/birdfacts/results/bob5920.htm
Guillemot	http://blx1.bto.org/birdfacts/results/bob6340.htm
Razorbill	http://blx1.bto.org/birdfacts/results/bob6360.htm
Puffin	http://blx1.bto.org/birdfacts/results/bob6540.htm
Fulmar	http://blx1.bto.org/birdfacts/results/bob220.htm
Shag	http://blx1.bto.org/birdfacts/results/bob800.htm
Arctic Skua	http://blx1.bto.org/birdfacts/results/bob5670.htm
Great Skua	http://blx1.bto.org/birdfacts/results/bob5690.htm
Great black-backed gull	http://blx1.bto.org/birdfacts/results/bob6000.htm
Common tern	http://blx1.bto.org/birdfacts/results/bob6150.htm
Sandwich tern	http://blx1.bto.org/birdfacts/results/bob6110.htm
Arctic tern	http://blx1.bto.org/birdfacts/results/bob6160.htm
Eider	http://blx1.bto.org/birdfacts/results/bob2060.htm
Common Scoter	http://blx1.bto.org/birdfacts/results/bob2130.htm
Cormorant	http://blx1.bto.org/birdfacts/results/bob720.htm

Cook, A.SC.P; Johnston, A; Wright, L.J; Niall, W & Burton, H.K. A review of flight heights and avoidance rates of birds in relation to offshore wind farms. Draft report of work carried out by the British Trust for Ornithology on behalf of the Crown Estate. December 2011 (draft)

Garthe, S. & Hüppop, O. 2004. Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. *Journal of Applied Ecology* 41: 724-734.

Parnell, M., Walls, R. J., Brown, M. D. & Brown, S. 2005. *The remote monitoring of offshore avian movement using bird detection radar at Weybourne, North Norfolk*. Central Science Laboratory, York, UK.

Petersen, I.K., Christensen, T.K., Kahlert, J., Desholm, M., Fox, A.D. 2006. *Final results of bird studies at the offshore wind farms at Nysted and Horns Rev, Denmark.* National Environmental Research Institute, Denmark.

Walls, R.J., Brown, M. B., Budgey, R., Parnell, M. & Thorpe, L. 2004. *The remote monitoring of offshore avian movement using bird detection radar at Skegness, Lincolnshire.* Central Science Laboratory, York, UK.

10.0 APPENDIX A2: ASSESSMENT OF COLLISION RISK TO COMMON TERNS GIVEN A VARIABLE POPULATION LEVEL

10.1 Introduction

The aim of this assessment is to calculate the number of common tern collisions with the European Offshore Wind Deployment Centre (EOWDC) given a variable SPA population. The requirement for this assessment follows a request from SNH.

The common tern population has significantly declined from the population present since SPA designation. The original collision risk assessment reported in the environmental statement followed the Band 2011 guidance and used density estimates that were obtained from boat surveys and hence was reflective of actual densities of flying birds during the survey periods. SNH requested that should the population increase from current levels the number of transits through the EOWDC turbines and the subsequent collision risk to common terns is to be investigated.

Two different approaches to calculate the monthly densities of birds in flight have been assessed here; a range-dependent density and a range independent density, in each case densities have been calculated using a population range from 10-1000 individuals.

10.2 Method

Two different approaches to calculate the density of birds in flight were used. The range-independent approach assumed that common terns were evenly distributed across their maximum foraging range. The range-dependent approach assigned proportion of common terns into distance bands from the colony according to their known foraging habitats. In both approaches the collision risk assessment was carried out using the Band (2011) model.

For each approach the density of birds in flight was calculated for population size of 10 to 1000 individuals. The input parameters to the Band model that are specific to the common tern are detailed in Table 10-1. The EOWDC input parameters have not changed from previous collision risk assessments and are detailed in Table 10-2. Monthly flight densities were derived for the two scenarios and inputted into the model for the months where common terns are expected to be present at the Ythan estuary SPA, this was April through to September.

Table 10-1: Common tern input parameters to the Band 2011 model.

Parameter	Unit	Reference source
Bird Length	0.33 m	BTO bird facts
Wingspan	0.88 m	BTO bird facts
Flight Speed	10.3 m/s	Pennycuick (1987)
Nocturnal Activity Factor	1	Garthe and Hüppop, (2004)
Flight Type	Flapping	-
Flight Height	8.26	Cook *et al*., (2011)
Proportion of flights upwind	50 %	-

Table 10-2: EOWDC input parameters to the Band 2011 model.

Parameter	Unit
Turbine model	10 MW
No of blades	3
Rotation speed	7.4 m/s
Rotor radius	75 m
Minimum height of rotor	25 m
Monthly proportion of time operational	85 %
Max blade width	6.5 m
Pitch	30 degrees

10.2.1 Range independent density (density is constant across the maximum foraging range)

The first approach calculates a density of flying birds independent of range from the colony. The maximum foraging range of common terns from previous studies is expected to be 30 km from Ythan estuary SPA, and has been illustrated as the green arc extending from the SPA colony (BirdLife, 2012).

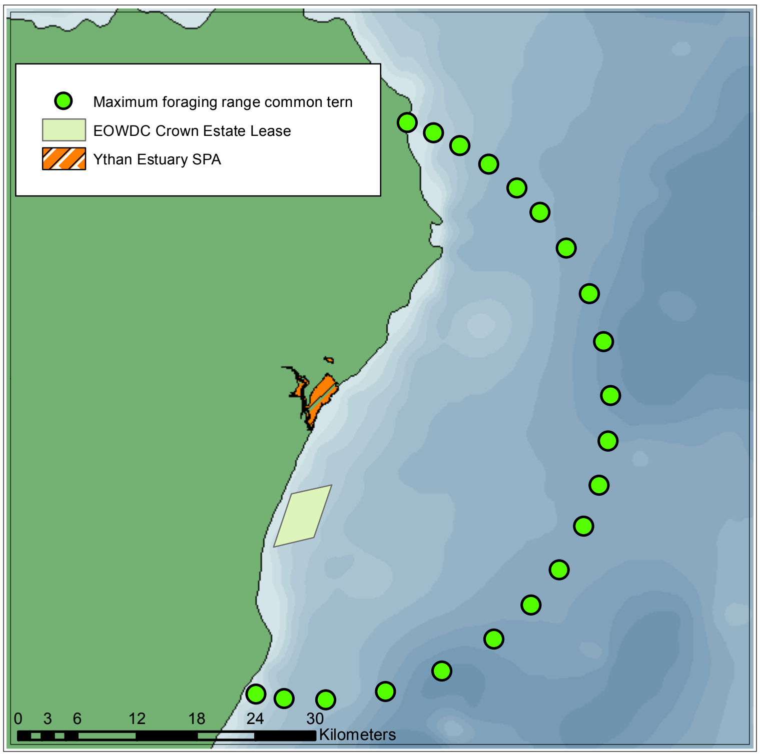

Figure 10-1: Maximum foraging range of the common tern from the Ythan estuary SPA

Common terns are assumed to be distributed evenly across their maximum foraging range, Density (D) of birds in flight can be calculated as follows:

$$Density\ (D)(km^2) = \frac{Population\ (P)}{Area\ (A)}$$

The area utilised by common terns can be considered to roughly equate to a semicircle, encompassing Aberdeen Bay and a small area to the south and north. The Area (A) is derived by the calculation below, the radius is the maximum foraging range of terns 30 km:

$$Area\ (A) = ½\pi r^2,$$

$$A = ½\pi 30^2,$$

$$A = 233\ km^2$$

Density of birds in flight is a reflection of the Population (P) present at the colony, the Population (P) values have used a range from 10-1000 individuals.

The relationship between the density of birds in flight and population are given in Figure 10-2 Tabulated densities for a sub-sample of the population model are given in Table 10-4.

Table 10-3: (10, 50, 100, 500 and 1000) have been used as examples in the collision risk assessment and are presented in the results section.

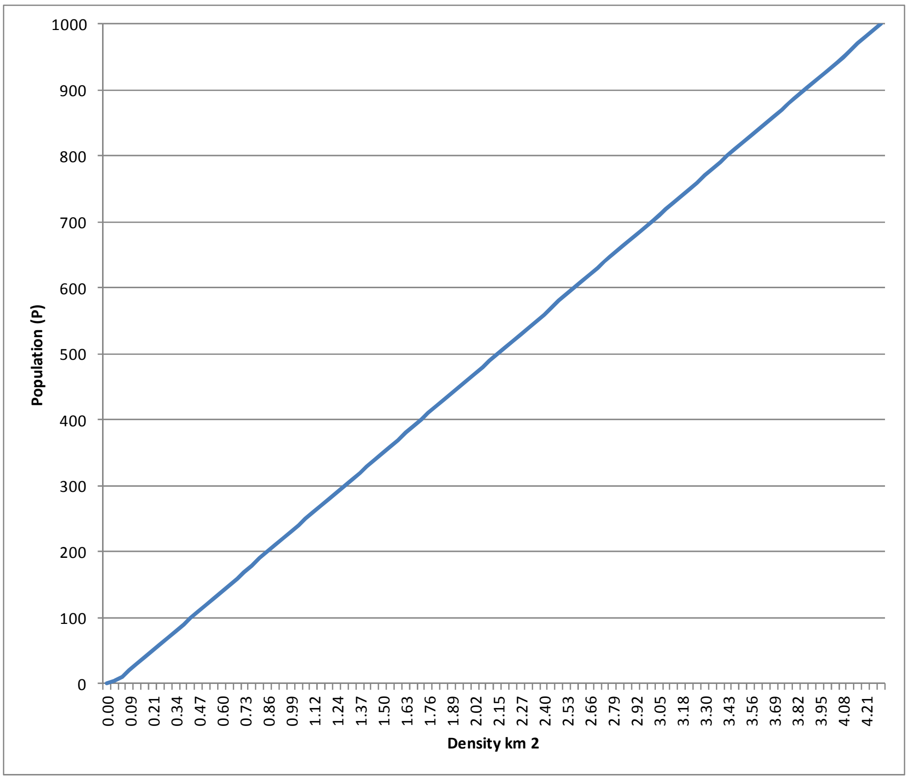

Figure 10-2: Relationship between number of individuals at colony and density of birds in flight, assuming all individuals are flying and evenly distributed across the maximum foraging range

Table 10-4: Number of individuals present in the colony and density of birds in flight assuming a range independent density. Maximum foraging range has been taken as 30 km from the colony. Entries shown in green have been used in the collision risk assessment.

Population	Density (km^2)
10	0.04
20	0.09
30	0.13
40	0.17
50	0.21
60	0.26
70	0.30
80	0.34
90	0.39
100	0.43
200	0.86
300	1.29
400	1.72
500	2.15
600	2.58
700	3.00
800	3.43
900	3.86
1000	4.29

10.2.2 Range dependent density (variable density across foraging range)

The second approach calculates a density of birds in flight that is dependent on the range from the colony. The seabird foraging database was used to determine the proportion of common terns that are expected to be found with increasing distance from the colony. The EOWDC is situated approximately 7.2 km from Ythan estuary SPA at its closest distance and 12.4 km away at its furthest distance away from the site. Given the relatively large distance the EOWDC licence area covers it could be expected that higher densities of common terns would be found in the northern area of the lease, and lower densities to the south further away from the colony.

For the purposes of collision risk modelling it was decided to use the mean distance of the minimum and maximum distances from the Ythan estuary SPA, this was calculated to be 9.8 km. At this distance the proportion of birds expected to be present would be approximately 90 % of the total population of the Ythan estuary colony (Figure 10-3).

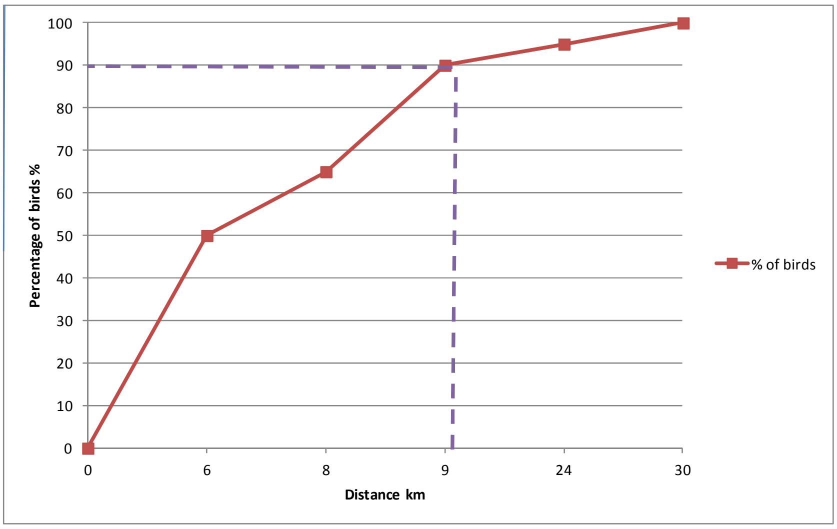

Figure 10-3: Cumulative frequency and proportion of common tern found foraging at different distances from colony (Reproduced from data points extracted from Birdlife Seabird Foraging Range Database). Purple line illustrates the percentage of common terns present at the mean distance the EOWDC is situated from the Ythan estuary SPA.

To calculate the foraging area used by 90 % of the population the following calculation is performed:

Firstly the Area (A) is calculated, where the radius is 9.8 km:

$$Area\ (A) = ½\pi r^2$$

$$A = ½\pi 9.8^2,$$

$$A = 150.85\ km^2$$

Density of birds in flight is a reflection of the Population (P) present at the colony, the Population (P) values have used a range from 10-1000 individuals. In order to calculate Density (D), 90 % of the population ($P_{90\%}$) was derived by determining 90 % of the total Population (P) modelled (see worked example below).

Density (D) of birds is calculated by:

$$Density\ (D) = \frac{Population\ (P_{90\%})}{Area\ (A)}$$

Worked example: Population of 1000 individuals, where $P_{90\%}$=900 and A = 150.85 km^2
D = 900/150.85
D = 5.97 km^2

The relationship between the density of birds in flight and population for a range-dependent density are given in Figure 10-3. Tabulated densities for a sub-sample of the population model are given in Figure 10-4: Relationship between number of individuals at colony and density of birds in flight, assuming all individuals are flying and have a range dependent density with 90 % of the population present within 9.8 km (area of 150.85 km2) from the colony.

. The relationship between density and population is a linear relationship with density increasing with population. Population values highlighted green in Figure 10-4: Relationship between number of individuals at colony and density of birds in flight, assuming all individuals are flying and have a range dependent density with 90 % of the population present within 9.8 km (area of 150.85 km2) from the colony.

(10, 50, 100, 500 and 1000) have been used in the collision risk assessment and are presented in the results section.

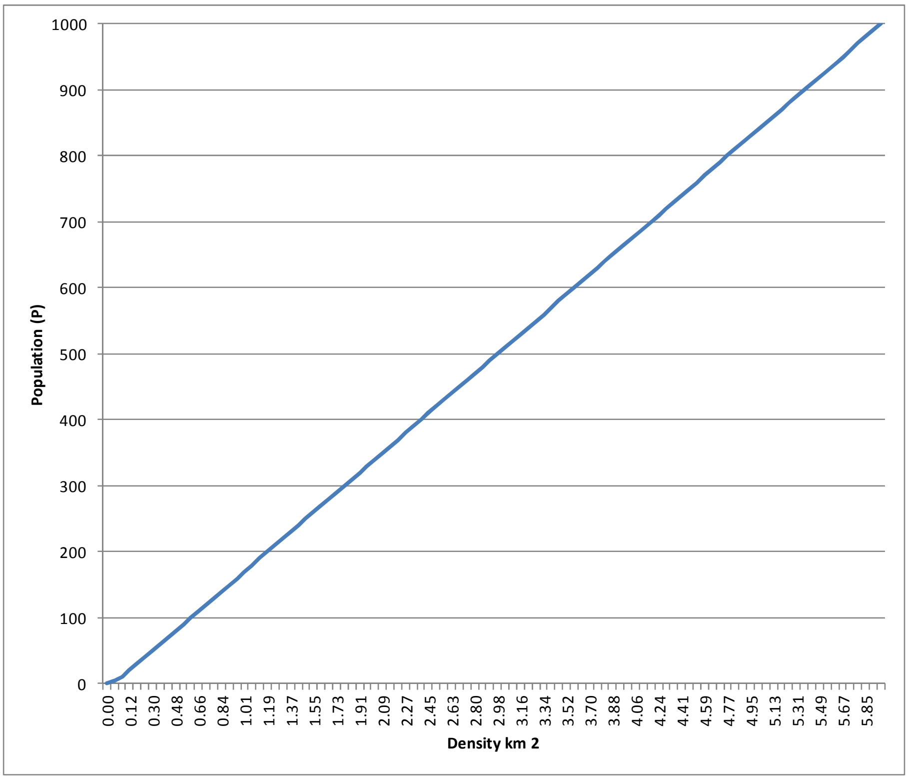

Figure 10-4: Relationship between number of individuals at colony and density of birds in flight, assuming all individuals are flying and have a range dependent density with 90 % of the population present within 9.8 km (area of 150.85 km^2) from the colony.

10.3 Results and discussion:

The results of the collision risk assessment for the two scenarios, range independent and range dependent are presented in Table 10-5 and Table 10-6 respectively. In both scenarios the number of collisions increases as the population of common terns increases. The scenario with the greatest number of collisions is the range dependent scenario as the densities of flying birds inputted into the Band (2011) model were larger than the range independent scenario.

Both approaches could be viewed as precautionary in that they assume all birds present at the colony will be flying offshore, this is likely to overestimate the densities at sea given that an unknown proportion of birds will be either at the colony or flying overland.

The Band 2011 model requires monthly flight densities to be inputted and the months of April to September were selected. This could lead to an increase in the number of collisions as not all the population modelled will arrive or depart at the same time.

In summary the collision risk modelling conducted does provide an indication of the collision risk to common terns should the Ythan tern SPA population increase. However the approach taken in this assessment has used theoretical densities of birds in flight derived from calculations of range-independent and range-dependent densities, and densities were not derived from conventional boat survey methods. Snapshot counts are believed to considerably underestimate the proportion of birds flying, whereas it could be argued that the approaches taken here would considerably over estimate the proportion of birds flying and therefore the results are expected to be present a worst-case and potentially unrealistic scenario for the various populations modelled.

Table 10-5: Summary of collision risk modelling outputs for a range of common tern populations, the number of collisions has been determined applying a range of avoidance rates 95 %, 98 %, 99 % and 99.5 %. Density estimates used in the model were calculated independent of range and were calculated assuming individuals were evenly distributed throughout the maximum foraging range (30 km).

Population	Number of transits through rotors	Collisions assuming no avoidance	Avoidance rates			
			95.00%	98.00%	99.00%	99.50%
10	682	49	2	1	0	0
50	2,387	172	9	3	2	1
100	4,888	352	18	7	4	2
500	24,440	1,760	88	35	18	9
1000	48,767	3,512	176	70	35	18

Table 10-6: Summary of collision risk modelling outputs for a range of common tern populations, the number of collisions has been determined applying a range of avoidance rates 95 %, 98 %, 99 % and 99.5 %. Density estimates used in the model were range dependent were calculated assuming 90% of individuals were present within the mean distance of the EOWDC (9.8 km).

Population	Number of transits through rotors	Collisions assuming no avoidance	Avoidance rates			
			95.00%	98.00%	99.00%	99.50%
10	455	33	2	1	0	0
50	3,410	246	12	5	2	1
100	6,821	491	25	10	5	2
500	33,876	2,440	122	49	24	12
1000	67,865	4,888	244	98	49	24

Out of the two approaches put forward it could be argued that the range-dependent density is the more preferable assessment as it better takes into account the distribution of birds within close proximity to the SPA colony.

10.4 References

Band, B. (2011). Collision risk model spreadsheet.

Birdlife Seabird Foraging Range Database, common tern foraging ranges extracted from http://seabird.wikispaces.com/Common+Tern: (Accessed 12/04/2012)

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11.0 APPENDIX A3: CUMULATIVE COLLISION RISK PINK FOOTED GOOSE IN ABERDEENSHIRE AND EOWDC ASSESSMENT OF COLLISION RISK TO PINK-FOOTED GOOSE

11.1 Introduction and Aim

Pink-footed geese were identified as a species of concern by Scottish Natural Heritage during their consultation response on the Environmental Statement (as submitted in August 2011). Concerns were raised regarding the potential cumulative collisions as a result of the European Offshore Wind Deployment Centre (EOWDC) and all the terrestrial wind turbines currently present in region.

Pink-footed geese undergo migratory movements across broad fronts during spring and autumn, consequently this species can be misrepresented in boat–based surveys, which prevents conventional collision risk assessments. This assessment has attempted to derive a method in which the total number of geese collisions associated migratory movements across the Aberdeenshire region and also the EOWDC can be calculated.

Aberdeenshire has an increasing number of wind turbines that are either already constructed or approved within the planning process, the latest estimates suggest 505 turbines are either operational or approved. There is considerable variation in the turbines within the Aberdeenshire region from small turbines attached to buildings to large commercial sized turbines. A large variability in the turbine characteristics prevents the collision risk assessment from being a simple process as it is impracticable to acquire all the turbine specific information within the large study area. This assessment has tried to simplify the process by grouping turbines into similar sized machines, this process is explained further in the methods.

11.2 Method

The collision risk model followed the Band (2000) collision risk guidance as this was the most applicable given boat based survey data was not used in the calculations.

11.3 Bird data

The bird data for the pink footed geese are detailed in Table 11-1. Movement of geese will be modelled assuming that there are 2 migratory transits through the study area per year. This approach will not be able to factor into non-migratory movements through the turbines out with the migratory period.

Table 11-1: Bird data for the Pink footed goose

Parameters	Unit
Bird length (m)	0.65
Wingspan (m)	1.53
Flight Speed (m/s)	18.8
Population	340,000

11.4 Study area

The study area encompassed the Aberdeenshire, as of April 2012 there were a total of 505 turbines that have been built or approved. The power and size dimensions of the wind turbines varies considerably, there are 230 turbines over 50 m in height and 275 being less than 50 m.

In order to calculate cumulative collision risk it has been necessary to determine the width of the study area. The shape of Aberdeenshire is complex with the border between neighbouring districts being highly convoluted, especially in the Cairngorms area (Figure 11-1). There are only two turbines within the highlands region west of Ballater. The horizontal distance from the Aberdeenshire border to the most easterly point is approximately 95 km. For the purpose of the assessment it has to be assumed that all the turbines within the Aberdeenshire region are essentially positioned in a straight line in order to calculate the total swept area in relation to the proportion of the study area, the calculations are explained further below.

Figure 11-1: Size and position of Aberdeenshire.

11.5 Turbine parameters

The collision modelling attempted to differentiate the potentially variable collision risk that would exist between turbines of different size and power ratings. In order to simplify the collision risk assessment two turbines have been chose as proxies for turbines greater and less than 50 m in height. The models chosen to reflect the turbines greater than 50 m was the Enercon-48 800 kW model, for the turbines less than 50 m an Endurance-3120 50 kW model was used. It is recognised that this results in a large simplification of the turbines present throughout Aberdeenshire but was necessary to process large numbers within the cumulative assessment.

The parameters that have been applied for the two groupings of Aberdeenshire turbines those less than 50 m and greater than 50 m in height are shown in Table 11-2. The EOWDC turbine parameters are also provided in Table 11-2. For the Aberdeenshire turbines a number of precautionary assumptions had to be applied to some parameters that were not available, or were expected to be site specific. For example a mean rotation per minute (rpm) value of 10 has been assumed for both sets of turbines and operational time has been assumed to be 85 %.

Table 11-2: Operational parameters for the cumulative collision risk model for the built and proposed Aberdeenshire turbines (<50m and >50 m) and the EOWDC turbines.

Parameters	**Turbines >50 m in height.** **Enercon E-48 (800kW)**	**Turbines <50 m in height** **Endurance E-3120 (50kW)**	**EOWDC turbines**
Turbine diameter (m)	48	19.2	150
No. of turbines	230	275	11
No. of rotor blades	3	3	3
Maximum chord width m	3	3	6.5
Mean revolutions per minute (rpm)	10	10	7.4
Pitch	30 degrees	30 degrees	30 degrees
Efficiency %	85 %	85 %	85 %

11.6 Calculations

The risk window (W) is the cross-sectional area = width x height. In the case of the turbines the width of the windfarm has been assumed to be 95,000 m, and the height is calculated from the turbine diameters.

$$Risk\ Window\ (W) = \ width\ x\ height$$

The area of turbines (A) is calculated from the number of turbines (N) x πRadius^2, where n is the total number of rotors and R is the rotor radius.

$$Area\ (A) = \pi r^2$$

The total rotor area is expressed as a Proportion (P) of the risk window by Area (A)/ Risk window (W).

$$Proportion\ (P) = \frac{Area\ (A)}{Risk\ Window\ (W)}$$

Number of birds passing through risk rotors (b) = number of birds through risk window x proportion occupied by rotors (P). In the case of a populations of pink footed geese of 340,000, 2 migratory movements will result in 2 x 340,000 (n = 680,000) geese transiting through the risk window per year.

$$number\ passing\ through\ rotors\ (b) = \ n\ x\ P$$

The probability of collision risk was calculated using the SNH supplied spreadsheet, this determines the probability of collision (p) for upwind and downwind flights and calculates and average collision. The number of birds colliding assuming no avoidance was first calculated by the number of birds passing through the rotors (b) x the probability of collisions $p_{(collision)}$, this calculation was applied on the average of the upwind and downwind collisions. The results for collision probability for the Aberdeenshire turbines less than 50 m and more than 50 m and the EOWDC turbines are presented in Table 11-5-Table 11-7

$$C(\text{no avoidance}) = b \times p(\text{collision})$$

Avoidance factors were applied to the number of collisions in order to better reflect birds behaviour to detecting the turbines. An avoidance rate of 99 % was applied to the number of collisions (with no avoidance.

11.7 Results and discussion

The cumulative number of collisions that are expected from all the Aberdeenshire turbines and the EOWDC turbines for a population of pink footed geese on their biannual migration is 150, this assumes an avoidance rate of 99 % of those flying through the turbines (Table 11-3 and Table 11-4). The results from the cumulative collision risk demonstrate that the EOWDC forms a very small proportion (2.25 %) of the total collisions of pink footed geese from the Aberdeenshire area.

Table 11-3: Collision risk calculations for risk window (W), Area of Turbines (A), proportion at risk (P) and total number of bird transits through A (b) for the <50 m turbines, >50 m turbines and the EOWDC turbines.

	<50 m turbine	>50 m turbines	EOWDC turbines
Risk window (W) m^2	1,824,000	4,560,000	14,250,000
Area of turbines (A) m^2	79,621	416,198	194,386
Proportion at risk (P)	0.04	0.09	0.01
Total number of bird transits through A (b)	29,683	62,064	9,275

Table 11-4: Collision risk calculations for the number of collisions assuming no avoidance and the 99% avoidance rate and operating efficiencies of 100% and 85% for the three turbines considered in the cumulative collision risk assessment <50 m turbines, >50 m turbines and the EOWDC turbines.

	Collisions assuming no avoidance	99% avoidance rate	85% efficiency
Aberdeenshire turbines <50 m	9,116	91.16	77.48
Aberdeenshire turbines >50 m	8,105	81.05	68.89
EOWDC turbines	398	3.98	3.38
Total (100% operating time)	17,619	176	-
Total (85% operating time)	149,76	150	-

The overall collision risk is reflective of the study area chosen, turbine parameters and numbers and behaviour of the geese assessed. The assumptions made in the assessment have undoubtedly influenced the results and should only be seen as being indicative and potentially precautionary.

11.8 Appendix A: Collision risk outputs from Band model

Table 11-5: Probability of collision, Band model outputs Aberdeenshire turbines over 50 m height

Calculation of alpha and p(collision) as a function of radius								
			Upwind:			Downwind:		
r/R	c/C	□	collide		contribution	collide		contribution
radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
0.025	0.575	14.96	48.26	1.00	0.00125	47.37	1.00	0.00125
0.075	0.575	4.99	16.39	0.87	0.00654	15.49	0.82	0.00618
0.125	0.702	2.99	11.20	0.60	0.00745	10.12	0.54	0.00673
0.175	0.860	2.14	9.26	0.49	0.00862	7.93	0.42	0.00738
0.225	0.994	1.66	8.11	0.43	0.00970	6.56	0.35	0.00785
0.275	0.947	1.36	6.55	0.35	0.00958	5.08	0.27	0.00743
0.325	0.899	1.15	5.46	0.29	0.00943	4.06	0.22	0.00702
0.375	0.851	1.00	4.65	0.25	0.00927	3.33	0.18	0.00663
0.425	0.804	0.88	4.02	0.21	0.00909	2.77	0.15	0.00627
0.475	0.756	0.79	3.52	0.19	0.00888	2.34	0.12	0.00592
0.525	0.708	0.71	3.10	0.16	0.00866	2.00	0.11	0.00559
0.575	0.660	0.65	2.75	0.15	0.00842	1.73	0.09	0.00528
0.625	0.613	0.60	2.45	0.13	0.00816	1.50	0.08	0.00499
0.675	0.565	0.55	2.19	0.12	0.00788	1.32	0.07	0.00473
0.725	0.517	0.52	1.96	0.10	0.00758	1.16	0.06	0.00448
0.775	0.470	0.48	1.76	0.09	0.00725	1.03	0.05	0.00425
0.825	0.422	0.45	1.58	0.08	0.00691	0.92	0.05	0.00404
0.875	0.374	0.43	1.41	0.07	0.00655	0.83	0.04	0.00385
0.925	0.327	0.40	1.29	0.07	0.00633	0.78	0.04	0.00383
0.975	0.279	0.38	1.18	0.06	0.00610	0.74	0.04	0.00386
	Overall p(collision) =			**Upwind**	**15.4%**		**Downwind**	**10.8%**
Average						**13.1%**		

Table 11-6: Probability of collision, Band model outputs Aberdeenshire turbines under 50 m height

Calculation of alpha and p(collision) as a function of radius								
				Upwind:			**Downwind:**	
r/R	**c/C**		**collide**		**contribution**	**collide**		**contribution**
radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
0.025	0.575	37.40	119.99	1.00	0.00125	119.10	1.00	0.00125
0.075	0.575	12.47	40.29	1.00	0.00750	39.40	1.00	0.00750
0.125	0.702	7.48	27.20	1.00	0.01250	26.11	1.00	0.01250
0.175	0.860	5.34	22.16	1.00	0.01750	20.82	1.00	0.01750
0.225	0.994	4.16	19.10	1.00	0.02250	17.56	0.93	0.02102
0.275	0.947	3.40	15.26	0.81	0.02233	13.79	0.73	0.02018
0.325	0.899	2.88	12.59	0.67	0.02177	11.20	0.60	0.01936
0.375	0.851	2.49	10.63	0.57	0.02120	9.30	0.49	0.01856
0.425	0.804	2.20	9.11	0.48	0.02060	7.87	0.42	0.01778
0.475	0.756	1.97	7.91	0.42	0.01999	6.74	0.36	0.01702
0.525	0.708	1.78	6.93	0.37	0.01935	5.83	0.31	0.01628
0.575	0.660	1.63	6.11	0.33	0.01870	5.09	0.27	0.01556
0.625	0.613	1.50	5.42	0.29	0.01802	4.47	0.24	0.01486
0.675	0.565	1.39	4.83	0.26	0.01733	3.95	0.21	0.01418
0.725	0.517	1.29	4.31	0.23	0.01661	3.51	0.19	0.01352
0.775	0.470	1.21	3.85	0.20	0.01588	3.12	0.17	0.01288
0.825	0.422	1.13	3.45	0.18	0.01513	2.79	0.15	0.01225
0.875	0.374	1.07	3.08	0.16	0.01436	2.50	0.13	0.01165
0.925	0.327	1.01	2.76	0.15	0.01356	2.25	0.12	0.01107
0.975	0.279	0.96	2.46	0.13	0.01275	2.03	0.11	0.01051
	Overall p(collision) =			**Upwind**	**32.9%**		**Downwind**	**28.5%**
			Average				**30.7%**	

Table 11-7: Probability of collision, Band model outputs for the EOWDC turbines

Calculation of alpha and p(collision) as a function of radius								
			Upwind:			Downwind:		
r/R	c/C	□	collide		contribution	collide		contribution
radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
0.025	0.575	12.94	41.81	0.82	0.00103	40.92	0.81	0.00101
0.075	0.575	4.31	14.23	0.28	0.00210	13.34	0.26	0.00197
0.125	0.702	2.59	9.77	0.19	0.00240	8.68	0.17	0.00213
0.175	0.860	1.85	8.10	0.16	0.00279	6.77	0.13	0.00233
0.225	0.994	1.44	7.12	0.14	0.00315	5.57	0.11	0.00247
0.275	0.947	1.18	5.76	0.11	0.00312	4.29	0.08	0.00232
0.325	0.899	1.00	4.81	0.09	0.00308	3.42	0.07	0.00219
0.375	0.851	0.86	4.11	0.08	0.00303	2.79	0.05	0.00206
0.425	0.804	0.76	3.56	0.07	0.00298	2.31	0.05	0.00193
0.475	0.756	0.68	3.12	0.06	0.00292	1.95	0.04	0.00182
0.525	0.708	0.62	2.76	0.05	0.00285	1.66	0.03	0.00171
0.575	0.660	0.56	2.45	0.05	0.00277	1.43	0.03	0.00161
0.625	0.613	0.52	2.19	0.04	0.00269	1.24	0.02	0.00152
0.675	0.565	0.48	1.96	0.04	0.00260	1.08	0.02	0.00143
0.725	0.517	0.45	1.75	0.03	0.00250	0.95	0.02	0.00136
0.775	0.470	0.42	1.58	0.03	0.00241	0.85	0.02	0.00130
0.825	0.422	0.39	1.46	0.03	0.00237	0.80	0.02	0.00130
0.875	0.374	0.37	1.34	0.03	0.00231	0.76	0.01	0.00131
0.925	0.327	0.35	1.23	0.02	0.00225	0.73	0.01	0.00132
0.975	0.279	0.33	1.13	0.02	0.00218	0.70	0.01	0.00135
	Overall p(collision) =			**Upwind**	**5.2%**		**Downwind**	**3.4%**
Average						**4.3%**		