CHAPTER 10: ORNITHOLOGY

Technical Summary

An intensive programme of monthly boat based surveys was conducted between December 2009 and November 2011, covering the entire Zone. A wide range of species and high numbers of individual birds were identified. Guillemots, kittiwakes and gannets were identified in the highest numbers within Project Alpha and Project Bravo. The data collected during boat based surveys were supplemented by previously undertaken aerial surveys, which included the wider area surrounding the Zone.

Impacts covering a range of potentially sensitive species have been assessed. Based on the worst case installation methodology the indirect effects upon birds from potential construction noise impacting prey species (key fish species being herring and sandeel), are predicted to have a significant impact on four species of bird: kittiwake, guillemot, razorbill and puffin.

Great black-backed gull is the only species for which collision risk with the wind turbine rotor blades during operation of Project Alpha and Project Bravo, both independently and in combination, results in a major significant impact. The impact upon birds from the construction and operation of the Transmission Asset Project is assessed as not significant for all sensitive species identified.

The Seagreen Project may also impact cumulatively, with neighbouring offshore wind farms to produce significant collision and displacement impacts to kittiwake, gannet, guillemot, razorbill, puffin, herring gull, lesser black-backed gull and great black-backed gull.

All of the impact assessments upon birds are considered to be a very precautionary and use a worst case scenario approach which identifies the worst possible level of impacts that could occur. In reality the impacts are expected to be less severe. Seagreen is committed to working with Marine Scotland and the Statutory Nature Conservation Bodies to reduce these impacts.

INTRODUCTION

10.1. Seagreen Wind Energy Limited (Seagreen hereafter) was awarded the rights to develop the Zone under a formal ZDA with The Crown Estate which states a generation capacity of up to 3,465MW.

10.2. Seagreen has divided the Zone into three discrete Phases of proposed sequential development. Phase 1 in the north of the Zone contains two contiguous sites, Project Alpha and Project Bravo, which incorporate most, but not all of the area of Phase 1, with the exclusion of Scalp Bank to the west and any areas considered of excessive depth (see Seagreen, 2011a). Project Alpha and Project Bravo are planned to contain up to 75 wind turbine generators (WTGs) each.

10.3. The wider Firth of Forth falls within the Aberdeen-Tees area one of most important areas for seabirds in the North Sea (Skov *et al.*, 1995). More specifically, the Outer Forth/ Wee Bankie/ Marr Bank area is considered to be of international importance for multiple seabird species (Kober *et al.*, 2009).

10.4. It is noteworthy that Wee Bankie and Marr Bank encompassed by the Zone, but falling outwith the area occupied by Project Alpha and Project Bravo, are viewed as particularly important (Wanless *et al.*, 1998, Camphuysen, 2005).

10.5. Scalp Bank, thought to be a favoured feeding ground for seabirds (and marine mammals), especially those targeting Lesser sandeel *Ammodytes marinus* (Wanless *et al.*, 1998), was excluded from development within Project Alpha and Project Bravo (Seagreen, 2011a). The potential importance of Scalp Bank was further noted during the first year of ornithological monitoring (Seagreen, 2011b).

10.6. The selection of Project Alpha and Project Bravo as viable sites for development was thus carefully undertaken. Nonetheless, it was still expected that there would be some sensitivities, not least as both sites fall within the foraging range of many species designated within four SPA seabird breeding colonies. In order of proximity (to one or other site) the sites are Fowlsheugh SPA (29km), Forth Islands SPA (53km), St Abbs to Fast Castle SPA (68km) and Buchan Ness to Collieston Coast SPA (84km) (see Volume II, Figure 9.3).

10.7. The number of breeding seabirds which could include Project Alpha and Project Bravo within their respective species-specific foraging ranges was conservatively estimated at 766,439 individuals using counts between 1998 and 2011 from the Seabird Monitoring Programme (SMP) database (http://www.jncc.gov.uk/smp/) and taking the respective foraging range of any seabird into account. [1]

10.8. The actual use of Project Alpha and Project Bravo by seabirds, including those originating from the respective SPAs was identified within the Baseline Technical Report (Volume III Appendix F1). As well as an intensive boat-based survey programme specific to Seagreen, individual tracking of selected seabirds at the Fowlsheugh, Forth Islands (Isle of May) and St Abbs to Fast Castle SPAs was undertaken through partnership within Forth and Tay Offshore Wind Developers Group (FTOWDG). The latter was especially useful to establish potential connectivity between the developments and SPAs. This issue is taken further in the accompanying Habitat Regulations Assessment (HRA) process.

10.9. A number of SPAs are present around the coastal fringe of the Forth Basin such as Forth Islands SPA, Montrose Basin SPA, Firth of Tay and Eden Estuary SPA and Ythan Estuary, Sands of Forvie and Meikle Loch SPA. Further SPAs such as the Slamannan Plateau SPA are sited immediately inland.

10.10. The designated waterfowl of the SPA sites noted above include geese such as Pink-footed Goose *Anser brachyrhynchus* and Taiga Bean Goose *Anser fabilis fabilis* and 13 species of wading birds including Common Redshank (hereafter Redshank) *Tringa totanus*, Red Knot (hereafter Knot) *Calidris canuta*, Bar-tailed Godwit *Limosa lapponica* and Common Ringed Plover (hereafter Ringed Plover) *Charadrius hiaticula* could conceivably cross Project Alpha and Project Bravo. Species such as Barnacle Goose *Branta leucopsis* originating from Svalbard are also known to cross the Forth on the way to the Upper Solway Flats and Marshes SPA on the west coast (Griffin *et al.*, 2011). All of these species needed to be considered in HRA and possibly also in Environmental Impact Assessment (EIA) within the ES (see Impact Assessment - Operation).

10.11. The focus of the Baseline Technical Report (Volume III, Appendix F1) was to identify those species for Project Alpha and Project Bravo to be carried forward into this chapter as sensitive receptors. The principles established by the IEEM (2010) were adopted throughout, with only those effects resulting from the development that were capable of generating a potentially significant ecological impact upon the species concerned to be considered.

10.12. This chapter describes the potential impacts and mitigation measures on these species during the construction, operational and decommissioning phases of Project Alpha and Project Bravo independently. The cumulative impact of the combination of both Projects is

1 A cap of 120km was applied, meaning that colonies of wide-ranging Northern Fulmar (many colonies) and Northern Gannet (a few colonies) at great distance were excluded.

then assessed followed by an assessment of cumulative impacts incorporating other identified developments. The Scottish Territorial Waters (STW) sites of Neart na Gaoithe and Inch Cape within the Forth were seen to be of particular relevance in this respect.

10.13. The Transmission Asset Project includes the Export Cable Route (ECR) corridor from the Seagreen Project (Project Alpha and Project Bravo) to the landfall point at Carnoustie, and therefore draws upon a diverse range of information in order to determine the extent of effects on ornithological receptors. This includes survey work of both the intertidal section of the ECR corridor and marine surveys of the Firth of Forth Zone.

10.14. This chapter provides an assessment of the potential impacts and mitigation measures on ornithological receptors during the construction, operational and decommissioning stages of the Transmission Asset Project.

10.15. This chapter of the ES was produced by ECON, Ecological Consultancy Limited (hereafter ECON) with specific input from AMEC in relation to consultation, with The Transmission Asset Project assessment produced by NIRAS Consulting.

CONSULTATION

10.16. Seagreen has undertaken extensive consultation relating to ornithology throughout the development of Project Alpha and Project Bravo. This has involved meetings, presentations, dialogue and correspondence with, amongst others:

- Marine Scotland;
- Scottish Government's advisers, the Joint Nature Conservation Committee (JNCC) and Scottish Natural Heritage (SNH), collectively known as the Statutory Nature Conservation Bodies (SNCBs); and
- Key stakeholders such as Royal Society for the Protection of Birds (RSPB).

10.17. Full details of all statutory and non-statutory stakeholder consultations are tabulated in the Consultation Report (Seagreen, 2012) that accompanies the Environmental Statement. This describes meetings, which have been undertaken by Seagreen alone and also as part of the Forth and Tay Offshore Wind Developers Group (FTOWDG).

10.18. Indirect consultation and advice received as part of The Crown Estate's (TCE) Strategic Ornithological Support Services (SOSS) group and through Marine Scotland is also documented.

10.19. Details of written responses that are either statutory e.g. scoping opinion, or contain advice that have been seminal to the development of Project Alpha and Project Bravo are included within the following:

10.20. Statutory scoping opinion for the Seagreen Project provided via Marine Scotland's Licensing and Operations Team (MS-LOT) is recorded in Table 10.1.

10.21. JNCC and SNH response to the Seagreen Year 1 Ornithology Survey report (Seagreen 2011b) is recorded in Table 10.2.

Table 10.1 Summary of consultation and issues relating to ornithology from the JNCC and SNH Scoping Opinion (All Annex references can be found in Appendix B2: Marine Scotland Scoping Opinion)

Date	Issue (Paragraph reference)	Relevant chapter section
08/ 09/ 2010	Zone survey design and methodology should be considered in relation to its ability to provide data suitable for determining baseline populations for EIA and sufficiency for HRA (1.2 and 1.18). Updated methodology should be provided (Annex B 1.20).	Assessment Methodology - Data Collection and Survey. Appendix F1 Baseline Report: Section 4 (Methodology).
	The relevance of tracking studies to determine SPA connectivity and the assumptions to be made in the absence of tracking data were raised (Annex B 1.4).	Assessment Methodology – Tracking of Individual Seabirds. Appendix F1 Baseline Report: Section 4.4 (Methodology – Tracking of Individual Seabirds).
	Data on migratory seabirds may not adequately be captured by boat-based surveys and barrier effects should be considered (Annex B 1.6-1.8).	Assessment Methodology – Linkage of Migratory Birds to Project Alpha and Project Bravo Assessment Methodology – Barrier Effects. Appendix F1 Baseline Report: Section 4.4 (Methodology – Collision Risk Modelling as a Screening Tool).
	Account of collision risk modelling should include discussion of uncertainties. Due to lack of evidence, avoidance rates cannot be advised.(Annex B 1.9-1.10).	Assessment Methodology – Collision Risk Modelling
	The 1% criterion for determining population significance should be used with caution and supported by information on population size and status (Annex B 1.12).	Assessment Methodology –Assessment of Significance
	Further advice will be provided on cumulative impacts (based on the FTOWDG cumulative ornithology report – AMEC 2010) and projects to be included. Compatibility of survey data between developers should be considered. (Annex B 1.13-1.14).	(Impact Assessment – Cumulative and In-Combination Appendix F1 Baseline Report: Section 4.4 (Methodology – Density and Population Estimates)
	Recommended that surveys are undertaken in sea states 4 or less only (Annex B 1.19).	Appendix F1 Baseline Report: Section 4.2 (Boat-based Survey – Density and Population Estimates)
	Aerial survey data (as well as boat-based) could be used to provide population estimates with associated confidence intervals (Annex B 1.22-1.23).	Assessment methodology - Aerial Surveys Appendix F1 Baseline Report: Section 4.2 (Boat-based Survey – Relative Importance of Population Size)
	Export cable route cannot be screened out as a source of potential impacts at this stage (Annex B 1.25).	Introduction

Table 10.2 Summary of consultation and issues relating to ornithology from the JNCC and SNH response to Seagreen Year 1 Ornithology Survey Report (Seagreen 2011b)

Date	Issue (Paragraph reference)	Relevant chapter section
10/ 08/ 2011	Passage species (non-seabird) – methods of assessment to be agreed via SOSS; passage species (seabird) – further advice to be provided.	Assessment Methodology – Linkage of Migratory Birds to Project Alpha and Project Bravo Appendix F1 Baseline Report: Section 4.4 (Methodology – Collision Risk Modelling as a Screening Tool).
	Use of DISTANCE software is recommended wherever possible for population estimates of birds on the water.	Assessment Methodology – Data Collection and Survey
	Use of IEEM guidance recommended for EIA.	Introduction
	Advise use of mean maximum foraging radii to determine zone of influence for breeding birds, primarily BirdLife database, but also any forthcoming publications and tracking data from FTOWDG, FAME and other projects.	Assessment Methodology –Population Size Appendix F1 Baseline Report: Section 2.1 (Importance of the Firth of Forth for Seabirds).
	When determining connectivity, 'interference' of same species colonies should be considered.	Appendix F1Baseline Report: Section 6 (Details of Sensitive Species)
	Analysis should be carried out for data collected in sea state 4 and below although surveying may be carried out in higher sea states should they arise during survey. Frequency of unsuitable sea states should be provided.	Technical Appendix: Section 4.2 (Boat-based Survey – Density and Population Estimates)

ASSESSMENT METHODOLOGY

Study Area

Project Alpha & Project Bravo – Immediate Study Area

10.22. The immediate study areas and main focus of this chapter are the footprints (not including potential effects beyond project boundaries) of the Project Alpha and Project Bravo developments comprising the Phase 1 component in the north of the Zone. The sites are broadly triangular in shape and adjoined along a southwest – northeast axis. Both sites are similar in size with an area of 197.2km^2 for Project Alpha and an area of 193.7km^2 for Project Bravo.

Wider Study Area

10.23. Boat-based data specific to the Firth of Forth Zone has not been analysed beyond the first year, especially for selected species (Seagreen 2011b), and were not available as a wider reference point. Seagreen informed Marine Scotland (MS) of the intention to undertake analysis in relation to the assessment of Phases 2 and 3 in the period of 2014 to 2016 (letter dated 21st May 2012). The principle of this approach has been accepted.

10.24. Two further approaches were used to represent the wider study area or region. The first was to utilise available data for the Outer Forth and Tay geographical area covered by aerial surveys specifically commissioned for the purpose by the Crown Estate in 2009 and 2010 (see Aerial Surveys, from 10.57 below), incorporating both the Zone and the STW sites closer to shore. The area covered was 5,754km^2.

10.25. The second approach was to use the foraging range for individual seabird species that breed in the Firth of Forth area (see 10.26 below). Both the mean maximum foraging range and the same with the addition of one standard deviation (as recommended to Marine Scotland by JNCC) were derived from Thaxter *et al.* (2012). Each range was then expressed as a radius from the combined sites, thereby encapsulating particular colonies identified in the SMP database. Known populations within colonies were also summed to provide a total population of each species in range.

10.26. Twenty-three breeding seabirds with the potential to interact with the Projects were identified. Of these, nine either did not have sufficient range from any colony to reach the Zone, even though they may have occurred with the breeding season or did not occur with the combined project area in the breeding season. Of the 14 species with the potential to interact with Project Alpha and Project Bravo in the breeding season a series of specific 'study areas' was generated.

10.27. Northern Fulmar (hereafter Fulmar) *Fulmaris glacialis* was the seabird with the largest foraging range (mean maximum of 400km + 246 SD – Thaxter *et al.*, 2012) and thus the greatest area from the Project Alpha and Project Bravo developments. The wider region, based on the foraging radius of Fulmar, extended to the Shetlands in the north and Argyll and Bute in the west of Scotland and down to Kent in the south encompassing an area of approximately 780,000km^2).

10.28. In contrast, with a foraging range of 26.4km (15.2km + 11.2 SD – Thaxter *et al.*, 2012) Common Tern generated the smallest study area of any species (4,843km^2) with this contained with the northwest part of the Firth of Forth.

Transmission Asset Project

10.29. The Transmission Asset Project is the collective term relating to the Offshore Transmission Owner (OFTO) assets that will be applied for under Marine Licensing. The components of the Transmission Asset Project are: the Offshore Substation Platforms (OSPs) including the collector and converter station platforms within the wind farm footprint, and the associated High Voltage cabling), the seaward portion of the ECR corridor; and the ECR corridor route up to Mean High Water Springs (MHWS).

10.30. The assessment of the Transmission Asset Project therefore comprises a combination of different habitat zones, involving offshore marine habitat within the wind farm footprint and the main portion of the ECR corridor, and intertidal habitat within the coastal portion of the ECR corridor.

Data Collection and Survey

10.31. The primary source of ornithological data for Project Alpha and Project Bravo was the specific boat-based survey programme undertaken by ECON. Secondary sources were tracking studies of selected species from the Isle of May in 2010 and from Fowlsheugh and St. Abb's Head in 2011 undertaken by the Centre for Ecology & Hydrology (CEH) for FTOWDG (Table 10.3), the aerial surveys of the wider Firth of Forth (see 10.57), and a large body of reference information for what is one of the best studied areas for seabirds in Europe (see Reference information, from 10.64 below).

10.32. Data from the offshore boat-based surveys were also used to inform the assessment of the OSP and High Voltage (HV) cable components of the Transmission Asset Project, whilst aerial data were used to assess effects on the seaward portion of the ECR. For the ECR route to MHWS, land-based Vantage Point (VP) surveys were conducted.

Table 10.3 Summary of key data and surveys.

Title	Source	Year	Reference
Reference information	Various, including the ESAS database, CEH's research on the Isle of May and University of Leeds research on the Gannets of Bass Rock.	2009 onwards	Published research as cited and referenced in the Technical Report, Volume III Appendix F1 and this chapter.
Aerial surveys	The Crown Estate	2009 and 2010	Volume III Appendix F1
Boat-based surveys	Seagreen	2009 -2011	Volume III Appendix F1
Tracking studies	CEH, commissioned by FTOWDG	2010 and 2011	Daunt *et al.* (2011a,b)
Vantage Point surveys	ATMOS	2011 - 2012	Volume III Appendix F1

Boat-based Surveys

10.33. A full description of the boat-based surveys and analysis is provided in the Baseline Technical Report (Volume III, Appendix F1). A brief summary follows.

10.34. Boat-based surveys were selected as the primary survey technique to characterise the ornithological interest of Project Alpha and Project Bravo as a result of the high degree of species identification of several groups of closely related and superficially similar species such as auks and gulls, coupled with specific information on the behaviour of the birds observed (e.g. foraging or actively feeding).

10.35. The separation of Common Guillemot (hereafter Guillemot) *Uria aalge*, Razorbill *Alca torda*, Little Auk *Alle alle* and Atlantic Puffin (hereafter Puffin) *Fratercula arctica* from each other, as well as splitting the gulls comprised of Black-legged Kittiwake (hereafter Kittiwake) *Rissa tridactyla*, Common Gull *Larus canus*, European Herring Gull (hereafter Herring Gull) *Larus argentatus*, Lesser Black-backed Gull *Larus fuscus*, Great Black-backed Gull *Larus marinus* was essential for the purposes of HRA and EIA as many, but not all, are linked to (generally) several different SPA breeding colonies.

10.36. The high-specification research vessel, the *MV Clupea* (Plate 10.1), was used for the surveys[2]. The *Clupea* exceeded COWRIE recommendations (Camphuysen *et al.*, 2004) for both vessel length (32.1m cf. >20 m) and minimum eye height (maximum of >7m standing cf. >5m). In fact, two observation platforms were available for the surveyors: a bespoke platform for the three bird surveyors fitted to the upper deck (see Plate 10.1) coupled with a chair fitted to the mid-deck forward of the wheelhouse used by the dedicated marine mammal surveyor (Plate 10.1).

2 The *MV Dornoch* was used for the March and April 2010 surveys due to the *Clupea* developing a serious fault. The *Dornoch* complied with COWRIE recommendations.

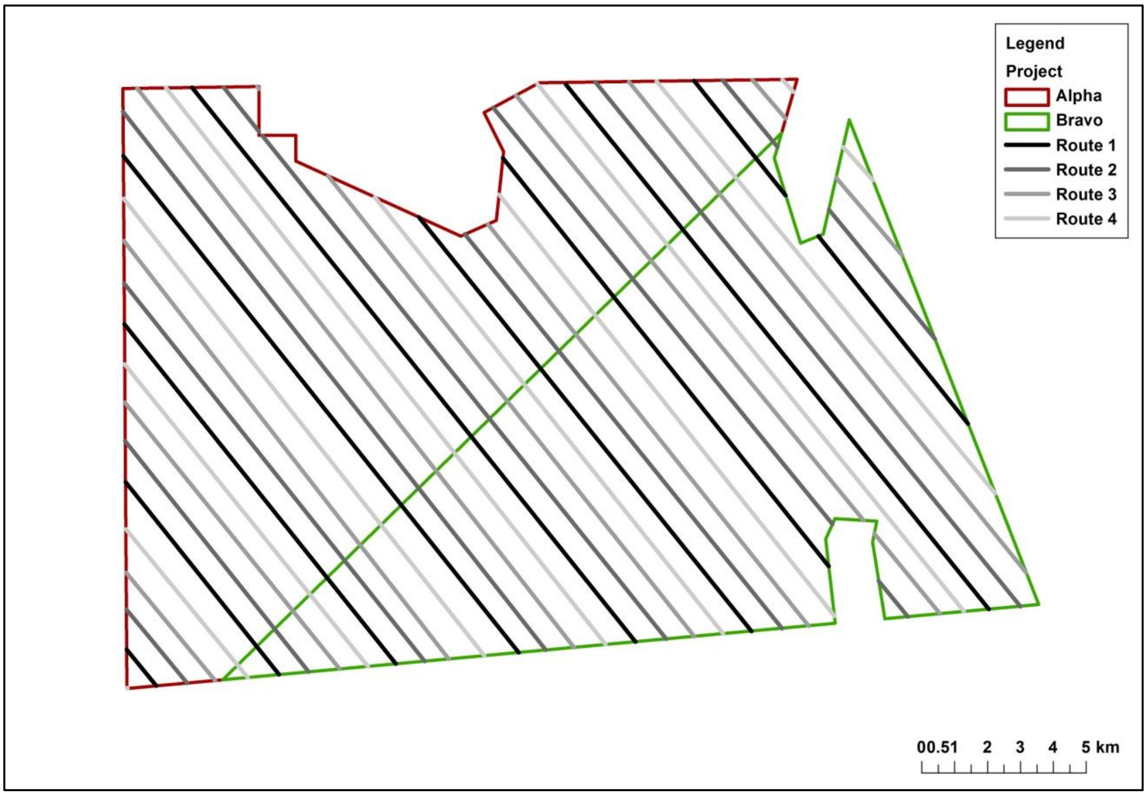
Plate 10.1 The *MV Clupea* employed for the boat-based surveys of Project Alpha and Project Bravo.

10.37. The survey programme consisted of 24 monthly surveys between December 2009 and November 2011 inclusive. A survey route with transects at 3km intervals with an orientation of northwest to southeast designed to intercept southwest or northeast flight lines into the Firth of Forth and its major colonies in the Forth Islands SPA including Bass Rock, was adopted.

10.38. A high level of coverage was seen to be essential to accurately determine fine-scale distribution patterns of seabirds that were likely to be determined by equally fine-scale patchiness of primary productivity (Scott *et al.*, 2010) and thus zooplankton and fish.

10.39. To achieve a high level of coverage, four different routes offset sequentially 750m to the west, were undertaken in each of three phenological periods comprised of breeding (April to July), dispersal (August-November) and winter (December to March). Within each period, the position of each route was randomly allocated within the framework of providing two surveys of each route in each period (see Plot 10.1).

Plot 10.1 The different boat-based transect routes across Project Alpha and Project Bravo.



10.40. In practice, a total, 23 surveys were completed, with the poor weather affected surveys of January and February 2010 combined to provide 100% coverage of Project Alpha and Project Bravo. A subsequent error in route selection leading to more surveys of one route compared to another over the two-year period was compensated for in terms of survey effort and thus did not affect distribution patterns.

10.41. The methodology used for the surveys broadly followed COWRIE recommendations (Camphuysen *et al*., 2004), with a number of modifications, noted in the update by COWRIE (Maclean *et al*., 2009).

10.42. The basic methodology was:

- both sides of the vessel were surveyed continuously, with all birds recorded;
- three skilled surveyors were used, with one for each side of the boat supported by one dedicated recorder;
- birds were initially detected by eye with identification aided by binoculars;
- all birds were assigned a real time (not a time bin) to aid positioning;
- all birds (and marine mammals) were identified to species where possible and assigned to distance bands on port or starboard, perpendicular from the boat (A = 0-50m, B = 50-100m, C = 100-200m, D = 200-300m and E > 300m);
- direction of travel and height (1 < 20m, 2 = 20-120m and 3 > 120m) was recorded for flying birds;
- details of age, plumage and behaviour were recorded where applicable;
- snapshot counts were recorded at 500m intervals;

- snapshots were divided into radial distance bands (of the same distance intervals of A-D noted above) resulting in a 180° arc extending 300m from the vessel; and
- sea state and other variables (glare, cloud cover and precipitation) were recorded. From survey nine onwards a general visibility score was also recorded.

10.43. To calculate density and population estimates for Project Alpha and Project Bravo, the data first had to be segregated by defining which survey cells, corresponding to 500m transect segments between snapshot locations, fell within the development footprints of each Project.

10.44. The density of birds in flight was derived from the number of birds recorded in snapshots (bands A to D) divided by the survey area calculated from the number of snapshots multiplied by the surveyed arc (radial) of 0.141km^2, as adopted elsewhere (e.g Spear *et al.*, 2004). Snapshots reduce the effect of movement bias, present in continuously collected data for flying individuals moving faster than the survey platform (Tasker *et al.*, 1984, van Franeker, 1994). Although birds were placed in radial distance bands during snapshots, given the potential difficulty correcting for birds in flight using DISTANCE and lack of specific guidance on the issue by the JNCC, no attempt was made to correct for decreasing detectability of birds at greater distance suggested by recent studies (e.g. Barbraud & Thiebot, 2009).

10.45. The potential for underestimation using the radial method is lower than using the European Seabirds as Sea Team (ESAS) 'box' method even if distance correction cannot be achieved. This is because the ESAS method carries an underlying anomaly in that birds may be recorded to a maximum of 424m from the observers (into the corners of the box) even where detection distance is set at 300 m. An unknown fraction of birds beyond 300m but within the box may be included as though they were within 300 m, within the area of 0.18km^2, sampled where both sides of the vessel are surveyed.

10.46. To ensure comparability between densities of flying birds generated from the ESAS method gathered at other sites and allow assessment in a cumulative context, it is recommended that any density derived from the latter be corrected by a factor of 1.28 to account for the likely area sampled (0.141km^2) compared to the area assumed (0.18km^2). The latter area cannot be sampled if a constant detection distance is assumed.

10.47. The density for birds on the water was calculated by the total count in bands A to D divided by the survey area derived from transect length multiplied by the surveyed width (0.6km). Simple correction factors to account for decreasing detection at increasing distance were developed and applied for the dominant auks. Correction factors simply assumed an equal number of birds were present in bands of equal width (i.e. 100m each of bands C and D relative to A+B combined).

10.48. The densities derived from the two different fractions of birds on the water and birds in flight were added together to provide an overall density, as typically undertaken by ESAS. Total population size was then estimated by overall density multiplied by the site area (Project Alpha – 197.2km^2 and Project Bravo – 193.7km^2).

10.49. However, DISTANCE analysis (see Buckland *et al.*, 2001, 2004, Thomas *et al.*, 2010) as recommended by JNCC (see Table 10.4) was preferred for birds on the water. The specific data requirements of DISTANCE meant that this could only be applied to Kittiwake, Guillemot, Razorbill and Puffin. Where sufficient data was available and the resulting model performance was satisfactory, density estimates were generated for each survey.

Otherwise a global model using data from all surveys was used to calculate density estimates for the survey.

10.50. Where possible, DISTANCE derived densities for birds on the water were combined with those for flying birds from snapshots (see 10.44 above) to produce an overall population estimate on each survey. For species without DISTANCE derived densities, the population size derived from ESAS methods, incorporating any correction factors used (see 10.46 above). Occasionally, bird species were either not recorded within line transect (birds on the water) or in snapshots (flying birds). In this case, an extrapolated population was derived from the number of individuals recorded in the area of survey scaled to the site area.

10.51. A visual representation of spatial distribution of seabirds was undertaken for birds on the water and flying birds (from snapshots only) separately. Using the geo-reference of individual birds, they were assigned to an individual 1km^2 cell within a grid overlain over Project Alpha and Project Bravo. To account for survey effort a weighted mean was calculated for each cell. The results were then plotted using coloured cells to represent variations in abundance across the sites.

Tracking of Individual Seabirds

10.52. To build on previous studies, FTOWDG commissioned CEH to track species thought likely to be important receptors of the developments at particular SPA colonies. These were Kittiwake, Guillemot and Razorbill breeding on the Isle of May during 2010 and Kittiwake breeding at Fowlsheugh and St. Abbs in 2011. In addition, FTOWDG purchased a small dataset relating to breeding Puffins tagged on the Isle of May in 2010.

10.53. Foraging distribution was quantified by attaching miniaturised GPS data loggers to breeding birds. Birds were captured at the nest to be fitted with tags and then recaptured to retrieve the tag and its stored data. The number of tags deployed and retrieved are summarised in Table 10.4.

Table 10.4 Summary of tags deployed and retrieved and the data gathered during the tracking studies

Colony	Species	Deployed	Retrieved	% Success	Number of trips	Number of GPS fixes
Isle of May	Kittiwake	74	36	49	91	26,545
	Guillemot	46	35	76	112	32,021
	Razorbill	25	18	72	111	19,462
	Puffin	10	7	70	15	8,971
Fowlsheugh	Kittiwake	54	35	65	93	32,875
St. Abbs	Kittiwake	32	25	78	70	20,015

10.54. The total number of fixes for Kittiwake was 79,435 from 254 trips, relatively evenly distributed between the colonies and years (Table 10.4). The number of fixes from Guillemot was comparable to a single year / colony of Kittiwake. The smaller dataset of Razorbill was seen to be similar in scope and patterns to that provided for Guillemot (Table 10.4). The Puffin dataset was further limited by the unfavourable response of several birds to tags/ handling. Nevertheless, the researchers at CEH noted that wider-range foraging trips appeared to be represented and that the dataset could represent a worst case scenario of the interaction between Puffins breeding on the Isle of May and proposed wind farms in the Firth of Forth.

10.55. The data from the retrieved tags was partitioned into locations according to flight and non-flight activity using individual flight speed, perhaps of relevance to the risk of collision with turbines and displacement respectively. Specific analysis suggested the datasets for Kittiwake, Guillemot and Razorbill were sufficient to estimate the range at sea, although this was not the case for Puffin (Daunt *et al.*, 2011ab). The use of space at sea for the former three species was estimated through analysis of kernel distribution.

10.56. Further specific analyses of tracklines were conducted in relation to Project Alpha and Project Bravo as well as the STW sites, Inch Cape and Neart na Gaoithe. The number and proportion of trips entering any site, the distance travelled within any site and the total GPS fixes according to flight and non-flight behaviours (and combined) was calculated both as a total for all birds and as a mean value by individual bird to account for any individual bias.

Aerial Surveys

10.57. A full description of the aerial survey methodology and analysis is provided in the Baseline Technical Report (Volume III, Appendix F1). Three summer surveys (2009) and four winter (2009/ 2010) covering Project Alpha and Project Bravo, the Zone and inshore waters over a total area of 5,754km^2, were conducted. Summer surveys divided the survey area into six blocks, whereas the winter surveys comprised of six different transect routes, each one covering the study area. The methodology used for the aerial surveys followed COWRIE recommendations (Camphuysen *et al*., 2004). In brief:

- Surveys were conducted from a Partenavia PN68 high-winged twin-engined aircraft. An altitude of 76m and a speed of c. 200km/ hr was maintained along transects of a north-south axis;
- Two experienced observers conducted the surveys over four hour flights in good weather conditions;
- The location of the aircraft was recorded every five seconds allowing accurate positioning of birds;
- For each bird observation, identity, count, general behaviour (e.g. flying), distance from the aircraft and time of observation was recorded and;
- The survey transect width was 956 m, sub-divided into four bands (A = 44 -163m, B = 163 -282m, C = 282 - 426m and D =426 -1000m). Birds were assigned to a band using a clinometer.

10.58. The speed of the survey platform determines that both birds in flight as well as those in flight are effectively stationary. Therefore, all records can be pooled for use in DISTANCE analysis. However, a combination of a limited number of records and low level of species identification meant that density and population estimates could only be produced for Gannet and Kittiwake and the species groups of auks and gulls.

10.59. The aerial surveys covered more or less the entire Firth of Forth region and thus indicated the relative importance of the population size of both Project Alpha and Project Bravo compared to the STW sites, Inch Cape and Neart na Gaoithe, in relation to the region was explored through the use of Jacob's selectivity index (D). Data were pooled according to survey effort across surveys in summer and winter periods as well as overall. Aerial survey included the seaward portion of the ECR from the Project Alpha boundary to approximately 10km from the coast.

10.60. A broad-scale visual representation of abundance and distribution of the different species/ groups was achieved by simply plotting all raw count data using proportional circles. Any variation in survey effort and routes between surveys was thus not specifically taken into account.

Intertidal Vantage Point Survey (ECR)

10.61. Winter coastal vantage point (VP) surveys were conducted between October 2011 and March 2012 (Atmos Consulting, 2012 and Appendix F2: Offshore Transmission Assets Project - Ornithological Technical Report). A simplified 'through the tide' count survey method was used to assess the abundance and spatial distribution of waterfowl and seabirds using the beach and near-shore sea areas, within a 2km radius of the land-based VP at the Carnoustie landfall location. The surveys therefore covered both the intertidal habitat potentially frequented by waders and wildfowl, and the immediate inshore waters that have the potential to support seaduck and other more marine species.

10.62. Counts were conducted twice per month, for three hours at low tide and three hours at high tide. All birds using the beach and near-shore sea area were recorded (standing/ resting, swimming or feeding). Each bird or flock was recorded as a single registration. Swimming birds were also tracked, although flights were not specifically targeted.

10.63. The Intertidal VP survey provides data to inform the assessment on intertidal and near-shore marine sections of the ECR. The assessment of the VP surveys was undertaken with reference to Wetland Bird Survey (WeBS) data, which was obtained from count sectors adjacent to the landfall at Carnoustie. Further details can be found in the Transmission Asset Baseline Technical Report (Volume III Appendix F2).

Reference Information

10.64. A comprehensive literature review was undertaken to inform the ornithological interest of Project Alpha and Project Bravo and its importance in relation to a regional, national and international context. The information gathered also included more general information on the ecology of relevant seabird species including population size, dynamics and trends, conservation status, breeding phenology and foraging patterns, behaviour and movements and patterns of dispersal and occurrence. Forrester *et al. (*2007) provide particularly useful information in a Scottish context.

10.65. Furthermore, the seabird interest of the area has been the subject of intensive research. CEH have focused on Kittiwake (see Daunt *et al.*, 2002, Bogdanova *et al.*, 2011), Puffin (see Wanless *et al.*, 1990, Harris *et al.*, 2010, Harris & Wanless 2011) and Guillemot (see Wanless *et al.*, 1998, 2005a,b) using the Isle of May as the primary study site. Many aspects of the biology of these species have been investigated, but with a focus on the links between breeding success and foraging ecology and including the effects of climate change and the impacts of commercial fisheries (see Wanless *et al.*, 1990, 1998, 2005a, Frederiksen *et al.*, 2004, 2007, Daunt *et al.*, 2008).

10.66. Northern Gannet (hereafter Gannet) *Morus bassanus* breeding on the second largest colony in the World for this species on Bass Rock in the Forth Islands SPA (Murray *et al.*, 2011) have also been the focus of research of the team at the University of Leeds. Particular attention has been given to the foraging movements from the colony (Hamer *et al.*, 2000, 2001, 2007), the links between foraging trip duration and provisioning behaviour (Lewis *et al.*, 2004) and colony size (Lewis *et al.*, 2001) and modelling of habitat associations (Skov *et al.*, 2008). Other researchers have studied movements of adults originating from Bass Rock outside the breeding season (Kubetzki *et al.*, 2009).

10.67. Reviews of research were commissioned from both CEH (Daunt *et al.*, 2011c) and the University of Leeds (Hamer *et al.*, 2011) by FTOWDG.

10.68. Further details on specific references can be found in the Baseline Technical Report (Volume III Appendix F1).

Approach to Assessment

Potential Ornithological Effects Assessed

10.69. Specific considerations of the effects of offshore energy proposals on birds in the guidance provided in NPS EN-3 (DECC, 2011), states that there are five potential impacts of offshore wind farms on birds:

- collision with rotating blades;
- direct habitat loss;
- disturbance from construction activities such as the movement of construction/ decommissioning vessels and piling;
- displacement during the operational phase, resulting in loss of foraging / roosting area; and
- impacts on bird flight lines (i.e. barrier effect) and associated increased energy use by birds for commuting flights between roosting and foraging areas.

10.70. In line with current thinking, the approach undertaken in this ES chapter has been to redefine the five potential effects as summarised in Table 10.5 according to their corresponding phase of development.

10.71. Disturbance should be seen as a precursor to displacement that occurs where disturbance is severe. Otherwise, disturbance often implies a short-term or temporary effect that is unlikely to impact upon the individuals or populations of birds concerned. In this ES, disturbance is limited to that initiated by moving physical objects (i.e. boats) or noise causing evasive action to be taken by birds including flushing, typically into flight or by diving in the case of pursuit swimmers such as auks. Displacement incorporating disturbance is therefore considered in both construction and operational phases (Table 10.5).

10.72. Barrier effects are also a form of disturbance leading to displacement. However, displacement may be defined as referring to those birds that would have utilised the resources within an area subsequently occupied by WTGs, whereas a barrier effect carries no such implication and tends to suggest the bird would have just used the airspace *en-route* elsewhere. It is therefore the disruption of preferred, presumably often direct, flight lines, that is investigated and the potential effect on energy expenditure. It is assumed that the presence of construction vessels and turbine bases without fitted towers or blades do not present a significant barrier to flying birds and that any effect would be most appropriately incorporated as disturbance. Barrier effects are thus considered in the operational phase only.

Table 10.5 Potential ornithological effects identified and assessed in this ES chapter.

Potential effect	Phase	Definition
Displacement	Construction and decommissioning	Disturbance from increased boat traffic and construction
Indirect effects	Construction and decommissioning	Impacts upon the distribution and abundance of prey and habitat conditions that subsequently affect birds
Collision	Operational	Mortality through collision with turbine blades
Displacement	Operational	Avoidance of the site resulting in a loss of usable area (i.e. direct loss of habitat)
Barrier effects	Operational	Disruption of flight lines and associated energy expenditure

10.73. The loss of direct habitat through the installation of turbine bases or other structures is typically often very small. It is also conceptually difficult to view the replacement of one, horizontal substrate for another, vertical, substrate as loss *per se*, but rather as restructuring of habitat. For this reason, direct loss is not considered, although any potentially ecologically meaningful change in habitat is considered (see below).

10.74. Potentially important changes in habitat conditions include those upon the prey within that habitat. A suite of different effects controlled by a variety of mechanisms may be involved, such as noise or the presence of turbine bases changing the distribution and abundance of fish prey. As any effect upon birds is not direct but mediated through change in their habitat conditions, such effects are best encompassed under the term 'indirect effects'.

10.75. It is also of note that indirect effects may be both negative with a decline in the numbers of birds or positive with an increase in birds, perhaps as a result of a new food source associated with reef effect of turbine bases (Linley *et al.*, 2007). Although the prospect of the latter may be mentioned, it is not specifically included within a particular section, as although it is likely to be positive, insufficient work has been conducted to allow this to be quantified. Moreover, any positive effect may be counteracted by the attraction of birds to turbine fields that could conceivably increase the risk of collision. In keeping with the focus of EIA on attempting to quantify negative impacts, assessment of indirect effects focuses on the potential consequences of changes in the abundance and distribution of fish prey especially through construction noise.

10.76. Collision risk is assumed to apply to collision with moving turbine blades only and is investigated by specific modelled techniques (e.g. Band, 2011). Although collision with other structures, such as meteorological masts and OSPs or even with vessels is possible, this is generally thought to be unlikely and insignificant. Moreover, collision risk is generally not applied to birds striking stationary turbine bases although this has been demonstrated for a few species such as Willow Ptarmigan *Lagopus lagopus columbarius* at Smøla onshore wind farm (Bevanger *et al.*, 2010). Conceivably, striking turbine bases is possible for low flying seabirds such as auks that are unaccustomed to encountering clutter in their visual environment (Martin, 2011). Even if this is possible, it is thought to be extremely unlikely to generate an effect of any significance.

Approach to the assessment of the Transmission Asset Project

10.77. The potential ornithological impacts assessed in relation to the Transmission Asset Project are outlined in Table 10.6.

Table 10.6 Potential ornithological effects identified and assessed in relation to the Transmission Asset Project

Potential effect	Stage
Disturbance, such as movement of vessels and piling (OSP installation) Displacement (due to cable and OSP installation) resulting in loss of foraging/ roosting area Indirect effects, such as changes in habitat or abundance and distribution of prey	Construction
Direct habitat loss Displacement, resulting in loss of foraging/ roosting area Indirect effects, such as changes in habitat or abundance and distribution of prey Disturbance from maintenance vessels	Operation
Disturbance, such as movement of vessels and piling (OSP installation) Displacement (due to cable and OSP installation) resulting in loss of foraging/ roosting area	Decommissioning

Scale of Assessment

10.78. In this ES, assessment was conducted at both the national scale (i.e. in relation to national populations) and at the regional scale in relation to the populations of designated colonies of birds in the breeding season only. A two-tier assessment was undertaken in recognition of the abundance of designated colonies of international importance (SPAs) although these are classed as regional level. Assessment of designated colonies operated as something of a precursor to HRA potentially highlighting areas of concern potentially requiring further analysis.

10.79. A two tier assessment was also in keeping with the nature of the assessment in that the effects of collision and displacement may be readily assessed at the national and regional level, whereas barrier effects and indirect effects are generally more applicable to breeding birds in the breeding season. In regard to regional assessment, this was undertaken for adult birds only and therefore numbers were adjusted according to age data collected during boat-based surveys. The exception were auks, where due to the small sample size, numbers were adjusted by a factor of 0.67 (the inverse of multiplying by 1.5 to account for non-adult birds) based on Wetlands International (2006) (largely supported by Wanless *et al. (*1998) which showed that 30% of auks within the Firth of Forth birds were non-breeders during the breeding season).

10.80. For the different effects assessed for the Seagreen Project, the outputs are shown in **bold** for **national-scale** assessment and in *italics* for *regional-scale* assessment. Results are ultimately summarised in this context.

Assessment of Significance

10.81. Standard EIA practice of assessing the significance of an effect through the use of a matrix combining the sensitivity of the receptor and the magnitude of the impact was undertaken for this chapter.

10.82. Each species carried forward as a sensitive receptor was assigned a sensitivity category from high to negligible based on guidance from IEEM (2010) and Percival *et al.* (1999). The criteria defining each category are shown in Table 10.7. Note that the four-point scale adopted for Project Alpha and Project Bravo has been adapted from other ESs for recent developments (e.g. Triton Knoll – Triton Knoll Offshore Wind Ltd (2011)), where the scale is from 'very high' to 'low'.

Table 10.7 Definition of the criteria used to determine the sensitivity category of each ornithological receptor assessed in this chapter adapted from Percival *et al*. (1999).

Sensitivity	Definition
High	Cited interest of a connected SPA(s), including species identified in the review by Stroud *et al.* (2001) and those within the assemblage of an SPA Internationally important numbers of a species within the site
Medium	Cited interest of a connected SSSI(s) Red and amber-listed species of BoCC UK BAP priority species Nationally important numbers of a species present within the site
Low	EU Birds Directive Annex 1, EU Habitats Directive priority habitat/ species and/ or Wildlife and Countryside Act Schedule 1 species Regionally important numbers of a species within the site
Negligible	Species listed under Article 1 of the Birds Directive Green listed species of BoCC

10.83. The sensitivities effectively rank the receptors in international, national and regional terms in high, medium and low categories respectively. Amber-listed species from the Birds of Conservation Concern (BoCC) defined by Eaton *et al.* (2009, 2011) have been given the same status as Red-listed species within the medium category, even though it would be intuitive to place Amber listed species in a lower category. This is because the JNCC have suggested that Amber-listed species are the Red-listed species of tomorrow (see Triton Knoll Offshore Wind Ltd 2011). The low category also collects species that are classified under various more general conservation designations that do not generate concerted and specific conservation efforts. Such species are given a lower priority than those that are a focus of active conservation.

10.84. The negligible category also includes all species listed under Article 1 of the Birds Directive that the JNCC have interpreted applies to all naturally occurring birds in the wild state in the European territory of the Member States to which the Treaty applies. Accordingly, all species are thus of some conservation concern apart from rarities or vagrants to the UK whose main populations lie elsewhere. Therefore, species defined as Green status in BoCC are also included in this category.

10.85. A risk-based approach to define the magnitude of an effect upon the population affected in the most extreme terms of mortality of individuals was undertaken. The definition of each magnitude category shown in Table 10.8, is based on a potentially significant effect on the population should >1% of adults be affected. Seabirds are characterised by high adult survival (and thus longevity) and low reproductive output (termed *k*-selected) unlike other bird species such as passerines with relatively low survival balanced by high reproductive output (termed *r*-selected).

Table 10.8 Definition of the magnitude of the effect of mortality upon the sensitive receptors assessed in this chapter.

Magnitude	Definition
High	>1% of the population affected
Medium	0.5 to 1% of the population affected
Low	0.1 to 0.5% of the population affected
Negligible	<0.1% of the population affected

10.86. The use of 1% is a ‘rule of thumb’ based on available evidence including the population modelling of Northern Gannet in the form of population viability analysis (PVA) using a matrix-based approach commissioned by the Strategic Ornithological Support Services (SOSS) for the wind industry (WWT Consulting, 2012). The density-independent version of the model suggested that growth of the Gannet population could be sustained up to a threshold of additional mortality of ~10,000 birds from an overall population of 890,000 individuals (i.e. 1.12% of the population).

10.87. Some studies have suggested that mortality of as few as 0.5% of adults may become important (Everaert & Stienen, 2007), but this remains largely untested on specific populations. Alternatively, the approach of potential biological removal (PBR) developed by Dillingham & Fletcher (2008) and used extensively by Watts (2010) in relation to potential wind farm mortality implies a higher rate of mortality of at least 2-3% of the population per annum may be sustained by many seabirds. The current trend for the population has considerable bearing on the outcome of PBR with a higher level of additional mortality sustained by increasing populations.

10.88. Mortality obviously occurs as a result of collision. However, for other effects, such as displacement, mortality cannot be assumed as no study associated with a wind farm has yet demonstrated an effect upon individual fitness that could lead to increased mortality of either adults or dependent chicks where the effect occurs upon provisioning adults. There was potential for an indirect effect through prey as a result of construction noise upon the subsequent breeding success of Little Tern *Sternula albifrons* (Perrow *et al.*, 2011), although this could not be conclusively demonstrated.

10.89. For this reason, assessment of displacement (see 10.114 below) and indirect effects (see 10.137 below) was not based entirely on mortality, but also used the loss of habitat, that had been previously established by Percival *et al. (*1999) as a useful criterion in wind farm assessment (Table 10.9). Note that the original five-point scale of Percival *et al. (*1999) has been curtailed with the very high category incorporated into the high category in this assessment. The medium, low and negligible categories remain unchanged.

Table 10.9 Definition of the magnitude of the effect of habitat loss upon the sensitive receptors assessed in this chapter after Percival *et al.* (1999).

Magnitude	Definition
High	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% of habitat lost
Medium	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 habitat lost
Low	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 habitat lost
Negligible	Very slight change from baseline condition. Change barely distinguishable, approximating to the 'no change' situation. Guide: < 1% of habitat lost

10.90. The linkage between the loss of foraging habitat to food supply and thence to breeding performance and subsequent survival for relevant species may be discussed using established principles (see Newton 1998, Furness 2007) and the known specific use of foraging habitat by the species concerned (see Daunt *et al.*, 2002, 2011abc), followed by a discussion of potential impacts at a population scale.

10.91. The matrix used to determine the significance of an effect by combining the sensitivity of the receptor species and the magnitude of impact is shown in Table 10.10. The matrix produced significance scores ranging from no impact to major. Those shaded red represent effects considered as significant within an EIA context.

10.92. It is assumed that both moderate and major impacts will require mitigation to ensure a more favourable response of the sensitive receptor. As a consequence and where required, details of potential mitigation and any residual impact are outlined after the assessment of each effect.

Table 10.10 Matrix to assess significance of the impact resulting from any combination of receptor sensitivity with the magnitude of effect.

Value / Sensitivity	Magnitude			
	High	**Medium**	**Low**	**Negligible**
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Negligible	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

Selection of Sensitive Receptors

10.93. The selection of sensitive receptors was undertaken using a two-stage approach. The first stage identified sensitive species through a number of quantitative and qualitative criteria. In brief, these were:

- population size – linked to international, national and regional importance;
- linkage to breeding seabirds in SPAs; and
- linkage to migratory species in SPAs such as waterfowl.

10.94. The second stage in the form of a discussion supported by the available literature considered the potential impacts of the Project Alpha and Project Bravo developments on the sensitive receptors. Risk of significant ecological impact upon a specified population, according to the principles established by the IEEM (2010) led to further assessment in this ES. The process was effect-specific in the sense that only those effects where there was a risk of significant ecological impact upon each species were included. This ultimately led to a variable number of effects being considered for each species in this ES.

10.95. Full details of the criteria used to establish sensitive species are presented in the Baseline Technical Report (Volume III Appendix F1), with a brief outline below:

Population size

10.96. An estimate of population size of each species in the Project Alpha and Project Bravo areas separately was generated for each boat-based survey. The maximum population size within the breeding season, passage and winter periods separately and specific to each species, was then compared with known population size at different geographical scales. Phenology was derived from the literature, principally BWPi (2004) with Forrester *et al. (*2007) used to provide the Scottish context.

10.97. Geographical scales were international, national and regional. The relative importance of the maximum population was assigned according to the 1% criterion, i.e. an internationally important population held >1% of the European population. The 1% criterion, whilst not necessarily of biological relevance, has remained as the standard for designating areas of conservation interest (Skov *et al.*, 2007).

10.98. For breeding species, the European (international) population size was derived from BirdLife International (2004) with the national population (United Kingdom) from Baker *et al. (*2006). Regional populations were based on the latest population counts in the SMP database for colonies within the mean maximum plus one standard deviation foraging range inkm (Thaxter *et al.*, 2012), from the development sites.

10.99. In passage periods, international importance was derived from the European breeding population of each species multiplied by 1.5 in accordance with Wetlands International (2006). National passage populations were derived from Stone *et al. (*1995) with numbers adjusted according to known subsequent population changes. Regional passage populations were derived by multiplying the density recorded in the western North Sea area incorporating the Firth of Forth, by the area covered by aerial surveys (see 10.61 above). Particularly low population estimates were checked for sense against specific literature for Scotland (Forrester *et al.*, 2007).

10.100. The wintering population of the North Sea incorporating North European countries as derived from Skov *et al. (*1995) was used to gauge international importance for selected species. National wintering populations were taken from Musgrove *et al. (*2011) where available or adjusted from Stone *et al.* (1995) (see Baseline technical report). Aerial surveys were used to generate regional population estimates for some species (see Baseline technical report Volume III Appendix F1). Alternatively, Stone *et al.* (1995) was used and estimates checked using Forrester *et al.* (2007). Table 10.11 summarises the different criteria used and the hierarchy of their use where more than one estimate may be generated is provided.

Table 10.11 Summary of the means of deriving the importance of a particular population at different scales for any seabird recorded in Project Alpha and Project Bravo.

Period	**Population scale**		
	International	National	Regional
Breeding	BirdLife International (2004)	Baker *et al.* (2006)	Foraging radii (Thaxter *et al.*, 2012)
Passage	BirdLife International (2004) and scaled x 1.5 (Wetlands International 2006)	Stone *et al.* (1995) adjusted to population trend	Stone *et al.* (1995) and qualified using Forrester *et al.* (2007)
Winter	North Sea population from Skov *et al.* (1995)	Musgrove *et al.* (2011), or Stone *et al.* (1995) adjusted to population trend	Aerial survey or Stone *et al.* (1995) qualified using Forrester *et al.* (2007)

Linkage of breeding seabirds at SPAs to Project Alpha and Project Bravo

10.101. According to the advice of the JNCC, species designated within SPAs not only include those named as qualifying species in Natura 2000, but also those named by Stroud *et al.* (2001) and included within the assemblage in either document. Designated species recorded during the breeding season as adults for species that can be aged, or assumed to be adult if ageing is not possible, within potential mean maximum (plus one standard deviation) foraging range of an SPA colony(ies) were classed as having potentially originated from said colony(ies).

10.102. The HRA Screening Report (Seagreen, 2011c) after comments from the JNCC identified eight species of breeding seabirds within four SPAs, which were at risk of '*likely significant effect*' (LSE) from both Project Alpha and Project Bravo according to the HRA process (Table 10.12). The potential occurrence of birds from an SPA colony was enough to take the species forward for further discussion within the Baseline Technical Report (Volume III Appendix F1) even if very few individuals were involved and population size was insufficient to be of regional importance. Following consideration of risks, most but not necessarily all, of these species were expected to feature within EIA in this ES.

10.103. The likely strength of linkage between a particular colony and Projects Alpha and Bravo was surmised from a discussion of the relative size and distance of colonies coupled with evidence of flight direction and especially specific tracking data where this was available (see Baseline Technical Report - Volume III Appendix F1 for further details).

10.104. The linkage of breeding seabirds in Table 10.13 with Project Alpha and Project Bravo also applies to the Transmission Asset Project, including the ECR corridor.

Table 10.12 Breeding seabirds and the SPAs in which they are designated at risk of 'likely significant effect' within the HRA process (after Seagreen, 2011c).

Species	SPA
Northern Fulmar	Buchan Ness to Collieston Coast, Fowlsheugh, Forth Islands
Northern Gannet	Forth Islands
Black-legged Kittiwake	Buchan Ness to Collieston Coast, Fowlsheugh, Forth Islands, St Abbs Head to Fast Castle
Lesser Black-backed Gull	Forth Islands
European Herring Gull	Buchan Ness to Collieston Coast, Fowlsheugh, Forth Islands, St Abbs Head to Fast Castle
Common Guillemot	Buchan Ness to Collieston Coast, Forth Islands, Fowlsheugh, St Abbs Head to Fast Castle
Razorbill	Fowlsheugh, Forth Islands, St Abbs Head to Fast Castle
Atlantic Puffin	Forth Islands

Linkage of migratory birds to Projects Alpha and Bravo

10.105. The HRA Screening Report (Seagreen 2011c) identified three species of goose and 13 species of wading bird designated within a number of SPAs (see 10.10 above), which were at risk of 'likely significant effect' (LSE) according to the HRA process. As such, these were considered as sensitive species warranting further discussion within the Baseline Technical Report (Volume III Appendix F1) despite, in the main, not occurring in boat-based surveys of the Zone.

10.106. Collision was perceived to be the key risk for these non-seabird species as they potentially crossed the airspace occupied by WTGs installed at Project Alpha and/ or Project Bravo. Collision risk modelling (CRM) was therefore undertaken on each species as a screening tool to determine if further investigation was required in EIA. Modelling was undertaken according to the principles established by Wright *et al. (*2012) for SOSS.

10.107. The Transmission Assets Project provides further likely linkages with migratory waterfowl. The ECR corridor landfall at Carnoustie lies 2km north-east of the Firth of Tay SPA and the relevant qualifying species for this site listed in Table 10.13 are material considerations in the assessment of this component of the Transmission Asset Project.

Table 10.13 Migratory waterfowl and the SPAs in which they are designated at risk of 'likely significant effect' within the HRA process (after Seagreen, 2011c).

Species	SPA
(Svalbard) Barnacle Goose	Upper Solway Flats and Marshes
(Taiga) Bean Goose	Slamannan Plateau
Pink-footed Goose	Firth of Forth, Firth of Tay and Eden Estuary, Montrose Basin, Ythan Estuary
Eurasian Oystercatcher	Montrose Basin, Firth of Forth
Common Ringed Plover	Firth of Forth
European Golden Plover	Firth of Forth
Grey Plover	Firth of Forth
Northern Lapwing	Firth of Forth
Red Knot	Montrose Basin, Firth of Forth
Sanderling	Firth of Tay and Eden Estuary
Dunlin	Firth of Forth
Black-tailed Godwit	Firth of Tay and Eden Estuary
Bar-tailed Godwit	Firth of Tay and Eden Estuary, Firth of Forth
Eurasian Curlew	Firth of Forth
Common Redshank	Montrose Basin, Firth of Tay and Eden Estuary, Firth of Forth
Ruddy Turnstone	Firth of Forth

Selection of sensitive receptors for EIA

10.108. Seabirds occurring in at least regionally important numbers in either Project Alpha or Project Bravo or deemed to have potential to link with a particular SPA were subject to discussion within the Baseline Technical Report (Volume III Appendix F1) under a series of headings outlining:

- population ecology;
- density distribution and population size;
- foraging range and potential origin; and
- summary of risks.

10.109. In the summary of risks section, the potential for collision with turbines, displacement, barrier effects and indirect effects of construction on prey was discussed. The review of the vulnerability of each species to the different factors associated with wind farms compiled by Garthe & Hüppop (2004) and Furness & Wade (2012) was interrogated, and reinforced by any evidence base from specific sites (e.g. Pettersson, 2005, Petersen *et al.*, 2006, Krijgsveld *et al.*, 2011).

10.110. In accordance with the reviews and studies described above, site-specific data was also used to guide to the assessment of particular impacts. The data and the nature of the guide provided were as follows:

- The likelihood of collision was guided by the number of the birds flying through the site coupled with the proportion of birds observed at risk height.

- Displacement occurs where seabirds are prevented from utilising the resources within the wind farm site. A significant ecological impact on a species in a particular area or colony is most likely when large numbers or a large proportion is affected. Therefore, the peak population estimate and its relative size in relation to a particular population was used as a guide to the potential impact, especially when coupled with the evidence for actual use of the area (e.g. feeding – see below).
- Barrier effects are only likely to be important for breeding species where individuals undertaking multiple movements across the site during the course of a breeding season (Masden *et al.*, 2009, 2010). The timing of records, the proportion of adults and the flight direction adopted were considered to determine the likelihood of barrier effects. Tracking studies also provided specific indication of the routes of foraging birds from particular colonies.
- Indirect effects may occur as a result of changing abundance or distribution of resources, especially prey. The importance of the habitat may be broadly illustrated by the occurrence of feeding birds, with a higher proportion indicating greater importance. The proportion of foraging birds in different periods thus provides a guide as to the likely importance of indirect effects should they operate. Further, the footprint for indirect effects, such as through construction noise from pile driving, may be far greater than the area contained within the development. The Firth of Forth is known to have a number of important areas for seabirds and it is the potential effect upon these that was of specific concern.

Selection of sensitive receptors for the Transmission Asset Project

10.111. The selection of sensitive receptors for the Transmission Asset Project followed the same process as for Project Alpha and Project Bravo and is fully described in the Transmission Asset Baseline Report (Volume III Appendix F2).

10.112. Birds occurring in at least regionally important numbers across the Transmission Asset Project or deemed to have potential to link with a particular SPA are discussed within the offshore ornithology Technical Report (Volume III Appendix F1) and within the Baseline Technical Report for the Transmission Asset Project (Volume III Appendix F2).

10.113. No sensitive receptors for intertidal / nearshore zones of the ECR were identified from the VP surveys at Carnoustie. All species recorded were in insignificant numbers and therefore, these species and data collected from the VP work is not carried forward in this assessment. Full survey results from the VP surveys are presented in the Transmission Asset Baseline Report (Volume III Appendix F2).

Analysis for Impact Assessment

Displacement

10.114. Displacement has been considered in all phases of the project. The assessment of displacement during the construction and decommissioning phases focuses primarily on disturbance from increased boat traffic using:

- knowledge of bird species, including behaviour observed in boat-based surveys such as the proportion of auks diving or taking flight in response to the survey vessel, and;
- information on the vulnerability of species disturbance taken from Garthe & Hüppop (2004) and Furness & Wade (2012).

10.115. Displacement during the operational phase may occur from avoidance of the site as a result of intolerance of the presence of novel structures such as WTGs, substations or metmasts, or disturbance as a result of increased vessel traffic associated with operation and maintenance. In relation to turbines, Larsen & Guillemette (2007) demonstrated that Common Eider (hereafter Eider) *Somateria mollissima* reacted negatively to the presence of the standing towers irrespective of whether the rotor blades were moving or not suggesting any displacement during operation may begin early in the construction phase regardless of the presence of vessels or construction noise.

10.116. Displacement may also occur as a result of changing habitat conditions (i.e. an indirect effect) making the area less attractive or even completely unattractive (see 10.137 below). In practice, the different mechanisms for the response may be difficult or even impossible to separate and have simply been described as displacement in this assessment. However, for the purposes of assessment, displacement was assumed to be linked to avoidance of the wind farm, with any indirect effects dealt with below (see 10.137). It is noted that habituation to novel structures almost inevitably occurs if the site continues to support desirable resources, especially food (see Petersen & Fox, 2007).

10.117. Despite the potential importance of displacement, there is no industry standard assessment methodology. Previous assessments may have assumed that all birds are displaced, although this is very unlikely to be true unless the avoidance distance is at least half of the maximum distance between adjacent WTGs. Whilst this is possible, judging from the studies onshore, many bird species show a relative tolerance of wind farms with the minimum distance of approach often being <400-500m and often much less, even of species such as geese that may be viewed to be sensitive (Larsen & Madsen, 2000, Percival, 2005, Hötker *et al.*, 2006).

10.118. Avoidance is however species-specific and also depends heavily on the circumstances. Percival (2005) cites an example where the same population of Barnacle Geese respond differently to turbines in different parts of their range with birds feeding to within 25m of turbines at a spring staging location, whereas on the wintering grounds, birds did not venture within 350m with depleted numbers up to 600m away. Hötker *et al. (*2006) showed that breeding birds were less sensitive than non-breeding birds. Classically, birds that are resource-restricted will risk closer approach than those that have greater choice (Percival, 2005).

10.119. Overall, in a study of 18 wind farms, avoidance of operational sites appeared to be far less important than construction-related disturbance effects, with little evidence for consistent post-construction population declines in a range of species from Grouse to waders and passerines (Pearce-Higgins *et al.*, 2012). Such an effect clearly implies the relative weakness of avoidance as a force structuring populations of breeding birds.

10.120. There is still a dearth of specific information on the avoidance of offshore wind farms despite a growing number of studies. Petersen *et al. (*2006) initially suggested that several species of gull were attracted to Danish wind farms, whilst species such as auks and divers appeared to avoid the sites to a distance of several kilometers. In contrast, at Egmond aan Zee, Lindeboom *et al. (*2011) suggested that these apparently sensitive species did not show a marked avoidance. Moreover, the ecologically similar Great Cormorant (hereafter Cormorant) *Phalacrocorax carbo* now perch on turbine platforms and heavily utilise the site as a new offshore foraging area.

10.121. As in the onshore situation, it would appear that avoidance of offshore wind farms by seabirds is likely to be both species-specific and heavily dependent on locality and the nature of the birds using the site. Breeding birds under the constraint of provisioning chicks may be far less likely to avoid turbine arrays. However, to date, very few studies of wind farms in areas utilised by breeding seabirds have been conducted.

10.122. With a paucity of information, a risk-based approach to displacement needs to be adopted, although the available evidence may be used to target the most likely areas of risk. In this assessment a stepwise two-stage approach was conducted:

- Step 1 established a precautionary view of displacement by assuming that all birds were displaced and that a proportion of these would die. The conditions under which this could generate a significant impact was demonstrated through matrix analysis. Qualification of the extent or proportion of displacement from the site allowed the matrix to predict an effect on a more realistic scenario; and
- Step 2 focuses on the loss of foraging habitat as the key variable, establishing the significance of the proportion of habitat lost compared to that available and supported by evidence of the quality of the habitat that may be lost.

10.123. Step 1 begins by broadly assessing the risk of displacement through a matrix assuming that WTGs effectively occupied the full extent of footprints of Project Alpha and Project Bravo. The matrix combined the proportion of birds (adults or chicks) that might be anticipated to die a result of different rates of displacement, expressed as the proportion of adult birds affected. The proportion of the population affected was then expressed in relation to the 1% threshold of a given population (see 10.96 above for further background). In the two-tier assessment (see 10.79 above), the effect upon the national population was quantified in the first instance with the population derived from the UK breeding population x 1.5 to account for immature birds (Wetlands International, 2006). Assessment of the effect in the breeding season upon the designated colonies within foraging range was then undertaken, taking the proportion of adults in the population into account.

10.124. The peak population estimate for each of the developments was considered to be the most appropriate metric to be introduced into the displacement matrix, although this may not capture all the individuals that may be affected. Alternatively, a cumulative total was deemed impractical as it assumes that all birds from each population estimate are different individuals, which is very unlikely, considering that individuals tend to repeat patterns of behaviour and visit the same foraging areas. Alternatively, a mean population was thought to underestimate the proportion of birds affected, especially for species that display considerable seasonal differences in population size.

10.125. An example of the risk-based matrix approach to displacement is illustrated below (Table 10.14). In this example, displacement of a peak population of 2,000 birds relative to a national population of 100,000 (i.e. 2% of the population) occurs. The % of the population represented is inserted in the cell in the bottom right corner. At this point, 100% mortality from 100% is assumed and then all other values are calculated accordingly. The colour coding shown corresponds to the magnitude categories in Table 10.8, with red illustrating a significant effect upon >1% of the population.

10.126. The weakness of this approach is that the judgment of the effect is based on a discussion of the amount of displacement that will be observed and if the level of mortality, if any, such displacement will cause. The basis of this approach is conceptually simple in that displacement could cause a loss of feeding/ foraging habitat for all or a proportion of the individuals utilising the project area. Loss of foraging grounds may have a negative impact on a bird's ability to provide sufficient food for their chicks. This in turn could lower chick survival rates and thus breeding productivity and ultimately recruitment into the adult population. Displaced adult birds may also have a reduced chance of survival, although this would invariably be less likely, as adults are known to be able to compensate for reduced food supply in a number of ways (e.g. abandoning the breeding attempt).

Table 10.14 An example of a risk matrix of displacement relative to mortality, where colour coding represents the relative risk of an ecologically significant impact, according to the magnitude of effect described in Table 10.8. Red illustrates a potentially ecologically significant impact

		Displacement (%)									
		10	20	30	40	50	60	70	80	90	100
Mortality (%)	0	0	0	0	0	0	0	0	0	0	0
	10	0.02	0.04	0.06	0.08	0.10	0.12	0.14	0.16	0.18	0.20
	20	0.04	0.08	0.12	0.16	0.20	0.24	0.28	0.32	0.36	0.40
	30	0.06	0.12	0.18	0.24	0.30	0.36	0.42	0.48	0.54	0.60
	40	0.08	0.16	0.24	0.32	0.40	0.48	0.56	0.64	0.72	0.80
	50	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
	60	0.12	0.24	0.36	0.48	0.60	0.72	0.84	0.96	1.08	1.20
	70	0.14	0.28	0.42	0.56	0.70	0.84	0.98	1.12	1.26	1.40
	80	0.16	0.32	0.48	0.64	0.80	0.96	1.12	1.28	1.44	1.60
	90	0.18	0.36	0.54	0.72	0.90	1.08	1.26	1.44	1.62	1.80
	100	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00

10.127. In practice, it is unknown what level of mortality may be experienced, it is simply a question of establishing of whether this it at all likely. The variability in response of birds in different circumstances (see 10.122 & 10.124 above) means that it is relatively straightforward for reasonable arguments to be presented that provide very different outcomes. In order to at least focus on the relevant part of the matrix, the approach suggested by Trinder *et al.* (2012), i.e. to establish the level of displacement that may actually be experienced at different radial avoidance distances is used.

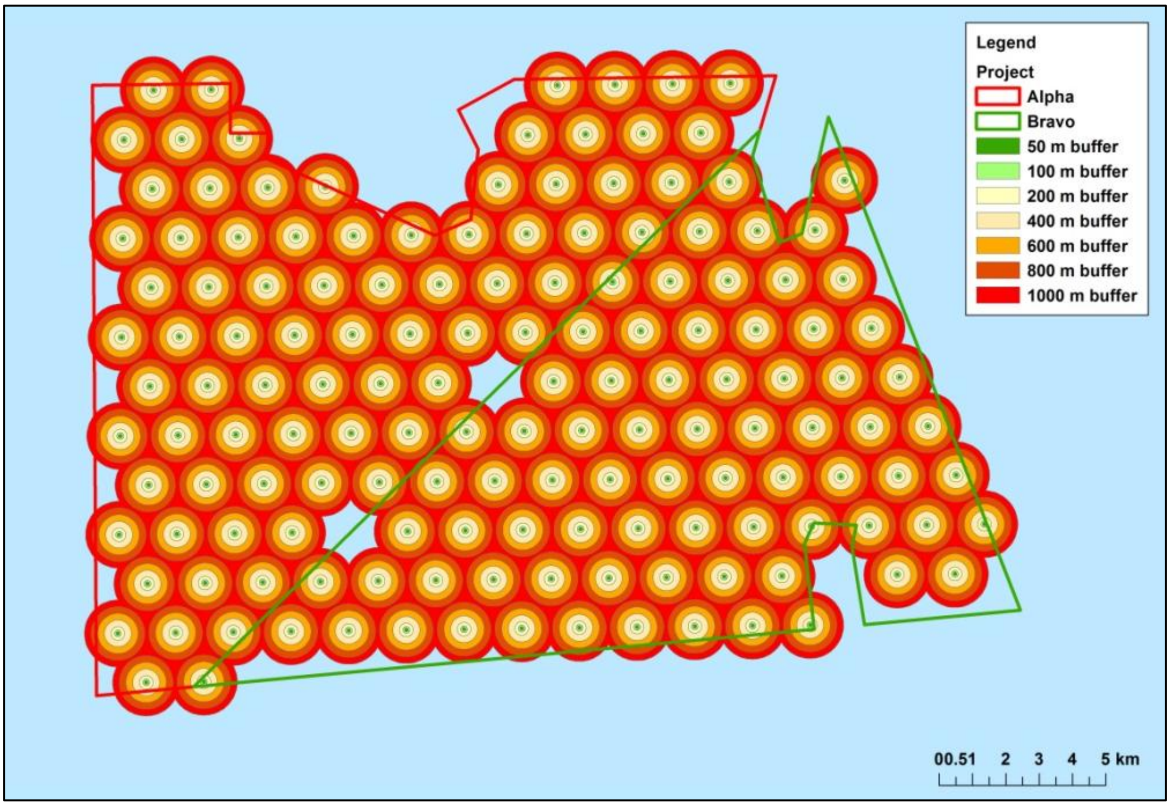
10.128. In the first instance, it was necessary to assess two WTG layout scenarios each comprised of 75 WTGs in Project Alpha and 75 WTGs in Project Bravo (for a total of 150 WTGs in total for the combined sites) to judge the worst case. The two scenarios were:

- an indicative layout where the WTGs are distributed evenly throughout each site; and
- an optimised layout where the WTGs are aligned in rows to better harvest the prevailing winds.

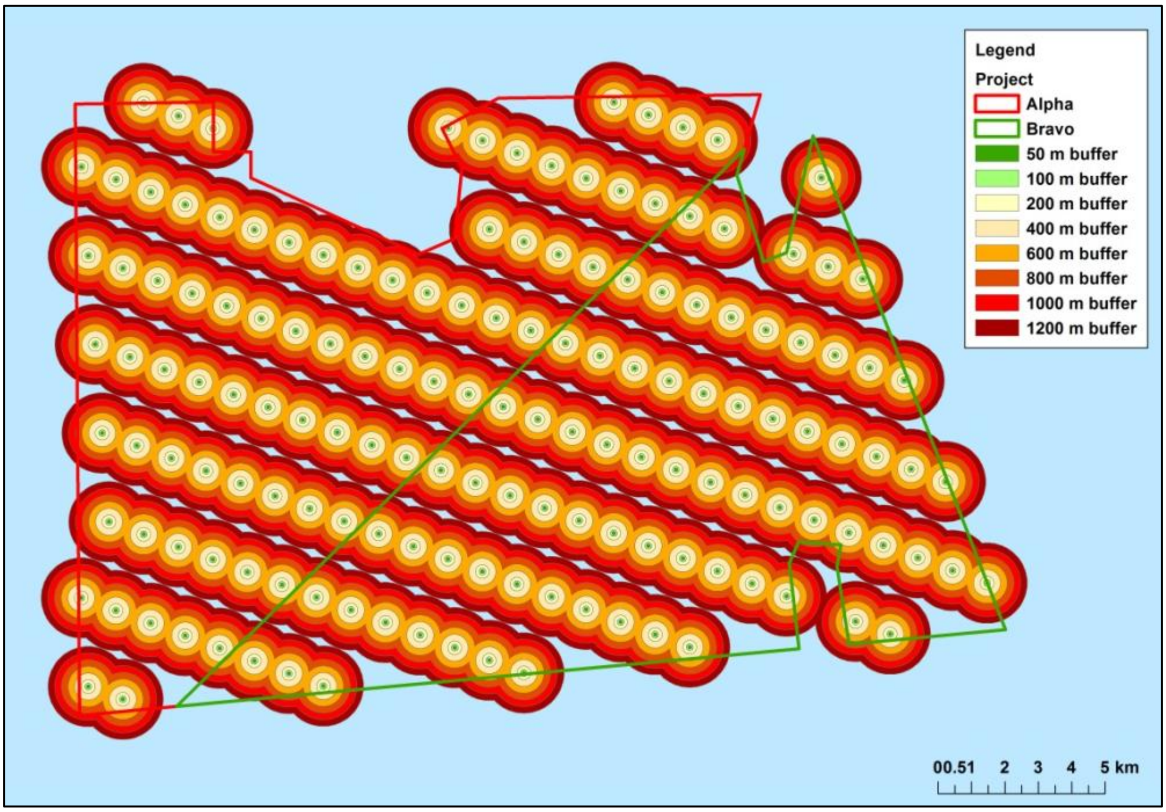
10.129. In both scenarios, the base of each WTG was assumed to be 7m in diameter. A series of avoidance radii were then applied using GIS (ArcGIS v.10.1) around each of the WTG bases at 50m and thereafter at intervals of 100m until complete overlap was achieved at > 1000 m, to represent potential displacement distances. Where buffers overlapped, these were merged using the dissolve function in ArcGIS to ensure that areas were not represented twice during calculations. The area of the resultant polygons was then calculated for the different displacement radii.

10.130. The procedure was carried out for WTGs in Project Alpha and Project Bravo alone, and for the two sites combined. The resultant radii for both the indicative and optimised layouts at Project Alpha and Project Bravo are displayed in Plots 10.2 & 10.3 respectively. It is apparent that in the optimised layout that the potential for overlap between WTGs is reduced at higher avoidance radii meaning that less displacement would tend to occur. However, this is dependent on the size of the radii and at smaller avoidance distances of ~500m or less there is little difference in terms of the proportion of the site affected (lost to birds) between either layout (Plot 10.4). Nevertheless, the worst case scenario was taken to be the indicative layout.

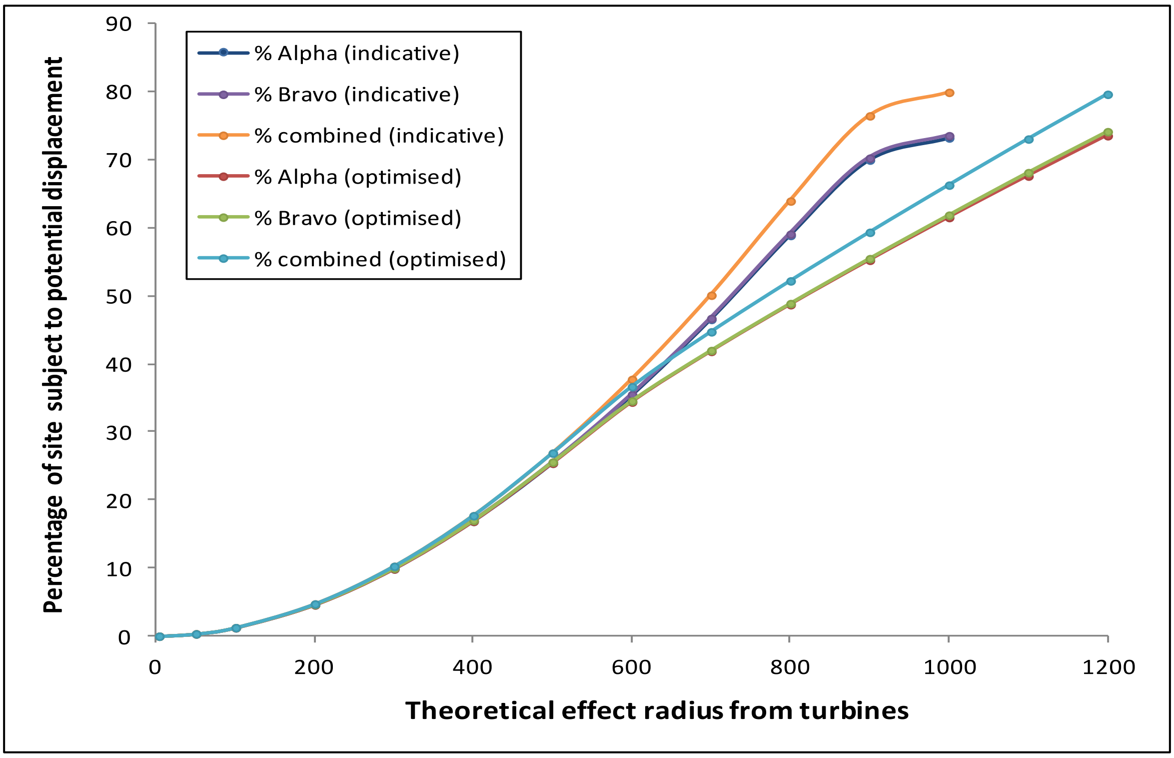
Plot 10.2 Examples of theoretical displacement radii around WTGs in the indicative layout for both Project Alpha and Project Bravo.



Plot 10.3 Examples of theoretical displacement radii around WTGs in the optimised layout for both Project Alpha and Project Bravo.



Plot 10.4 Relationship between theoretical effect radius and the percentage of Project Alpha and Project Bravo (and combined) subject to potential displacement effects with different layouts.



10.131. For the indicative layout, the proportion of each site subject to displacement at different avoidance radii was then calculated. Due to the positioning of the WTGs within the sites, an avoidance radius of >400m from some WTG influenced areas outside of the site boundary. To account for this, the radii applied to the WTGs were also applied as a buffer to the sites, thereby effectively enlarging the area of the site. It was this revised area, relative to each avoidance radius that was used to calculate the area of the 'site' that was potentially affected. This meant that 100% of the 'site' could never be affected (Table 10.15).

Table 10.15 Area and percentage of area affected of Project Alpha and Project Bravo (and combined) at avoidance radii ranging from the WTG to 1,200m based on the indicative turbine layout.

Avoidance distance radii (m)	Area affected (km^2)			Percentage (%) of area affected		
	Alpha	Bravo	Combined	Alpha	Bravo	Combined
3.5 (WTG)	0.00	0.00	0.01	0.0	0.0	0.0
50	0.67	0.67	1.35	0.3	0.3	0.3
100	2.52	2.52	5.05	1.2	1.3	1.3
200	9.76	9.76	19.52	4.6	4.7	4.7
300	21.70	21.70	43.41	9.9	10.0	10.3
400	38.36	38.36	76.72	16.9	17.0	17.7
500	59.73	59.73	119.46	25.4	25.6	26.9
600	83.51	83.51	166.73	34.4	34.6	36.7
700	104.83	104.83	208.19	41.9	42.0	44.7
800	125.85	125.85	248.41	48.7	48.9	52.2
900	147.06	147.06	288.45	55.3	55.5	59.4
1,000	168.66	168.66	328.74	61.5	61.9	66.3
1,100	190.76	190.76	369.50	67.6	68.2	73.1
1,200	213.41	213.14	410.57	73.6	74.2	79.7

10.132. It is of note that as a result of the large relative size of both Project Alpha and Project Bravo relative to the number of turbines the inter-turbine interval has been set as a minimum of 610m although this could be as high as 835m under the parameters of the Rochdale envelope. As such, the maximum distance between adjacent turbines or rows is likely to be much higher offering considerable scope for movement of both flying and swimming birds within the wind farm even under the worst case scenario of the indicative layout. A minimum value of around 25% of the area of each site is affected even when avoidance distance is set at around 500m (Table 10.15).

10.133. The approach was then to set an appropriate avoidance radius for each species and use the resulting area affected (Table 10.15) within the risk matrix of displacement versus mortality (Table 10.14). Discussion on the level of mortality that may result from this displacement could then be undertaken in a more focussed way.

10.134. Any discussion surrounding potential mortality as a result of displacement is best undertaken in the context of foraging habitat lost in what is Step 2 of the assessment (see 10.122 above). For this to be meaningful both the amount of habitat lost relative to that available and the quality of that habitat should be taken into account. The proportion of habitat lost within the site generated from Table 10.14 could be readily compared to that available within the mean maximum foraging range for the species. The significance of the resulting loss of habitat may then be established by using the proportion of habitat in the matrix shown in Table 10.9 combined with the sensitivity of the receptor as shown in Table 10.10.

10.135. Moreover, the tracking studies conducted on several species (see 10.52 above) and resulting calculation of kernel distribution provide a broad indication of the distribution of habitat quality, with the 50% kernel treated as representing core foraging habitat (Daunt 2011a,b). At this stage it is important to establish if any part of either Project Alpha or Project Bravo fall within core foraging habitat. If not, the argument may be that the loss of non-core habitat is not likely to be important and would certainly be extremely unlikely to lead to mortality of adults and probably also chicks.

10.136. It is also important to note that core foraging habitat may change between years (see Daunt *et al.*, 2011c), with a likely increase in area when resources are more limited. However, this need not increase the relative importance of more distant areas including the sites, as it is argued that recruitment of seabirds is typically dependent on a few good years with plentiful resources. Whilst it is possible that these resources may be exploited by adults provisioning chicks at larger than optimal distances from the colony, it is usually the case that breeding productivity is at its highest when resources are close to the colony. Although it may be difficult to definitively establish the optimal distance this could be illustrated by the distances travelled by birds in a good year.

Indirect Effects

10.137. As indicated above (see 10.110), the assessment of indirect effects focussed on the indirect effect of development of Project Alpha and Project Bravo upon the available prey resource, thereby generating a particular form of displacement. The potential effect of noisy construction, especially pile-driving upon sensitive fish species is well known as a result of both practical (e.g. Caltrans, 2001) and theoretical studies (e.g. Thomsen *et al.*, 2006). Whilst the effect of construction is typically framed as a short-term event as sensitive fish species are temporarily displaced, this can extend into the longer term should the recruitment of stock be affected in some way, with an impact upon the foraging success and perhaps even breeding performance of the dependent seabirds (Perrow *et al.*, 2011).

10.138. It is possible that the presence of turbines then changes the nature of the fish assemblage through the reef-effect (Linley *et al.*, 2007) thus influencing the relationships between predators and prey. However, with so little work on this aspect, which is generally thought to be broadly positive, no assessment of this aspect of reef effects is undertaken here. Moreover, there is evidence from onshore sites where indirect changes in habitat conditions ultimately increased the susceptibility of some birds (typically raptors) to collision as a result of being attracted to the wind farm by enhanced densities of prey linked to the habitat around turbine bases (Smallwood *et al.*, 2001). With no effective means of quantifying or even establishing the likelihood of this effect, estimates of collision mortality (see 10.156 below) based on current density estimates, are assumed to be sufficiently precautionary to encapsulate any minor increases as a result of attraction.

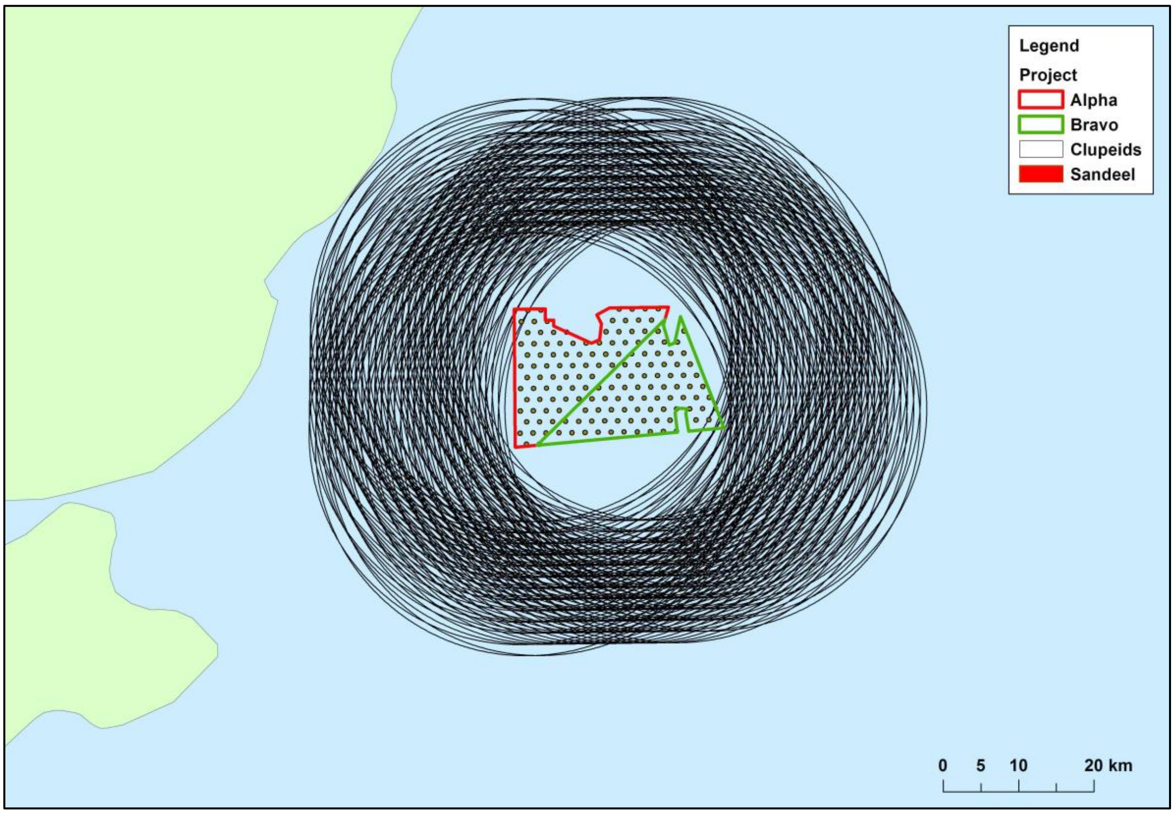
10.139. In a similar way to displacement, a twin-strand process of assessment was adopted. First, the assessment of the developments upon natural fisheries (see Chapter 12: Natural Fish and Shellfish Resource) was used. More specifically, the predicted magnitude of the effect upon the different species of relevance to birds as prey was combined with the sensitivity of the bird species assessed, in a standard manner within the matrix designed for the purpose (Table 10.10). The magnitude of effect upon the different fish species incorporated their specific susceptibility to noise as predicted by modelling of worst case piling activity.

10.140. The second strand of assessment was to assume that the impact range of pile driving leading to a strong avoidance reaction for different fish species impact would lead to complete displacement of all fish of this species and thus all dependent birds within the area affected. For the two species groups of most relevance to birds, the impact ranges were very different at a maximum of 28km for the hearing-specialist Herring *Clupea harengus* (with Sprat *Sprattus sprattus* assumed to the same) and just 0.2km for the hearing generalist sandeel *Ammodytes* spp. (Chapter 12: Natural Fish and Shellfish Resource). The resultant areas affected around each WTG in the indicative layout are shown in Plot 10.5.

10.141. With piling in one location at a time, it was assumed an area of 2,467km^2 would be continuously affected over the piling period in relation to clupeids (see Chapter 5: Project Description). In relation to sandeels, a much smaller area of 0.13km^2 would be affected under the same piling regime. The area of habitat lost was expressed as a proportion of the total foraging habitat of the bird species concerned (see 10.134 above), with the resultant value used as the magnitude of effect to be combined with the sensitivity of the receptor in the standard matrix (Table 10.10).

10.142. It is also noted that the footprint of effect upon clupeids of all WTGs but especially on the southern edge of Project Bravo, impinge on the higher quality foraging habitat of Marr Bank and Wee Bankie that falls within the core foraging habitat of many species (Daunt *et al.*, 2011a,b,c). Moreover, another favoured area for foraging seabirds, Scalp Bank is incorporated within the footprint of all WTGs especially in Project Alpha, but also including Project Bravo (Plot 10.5). A discussion of any indirect effect upon core habitat is conducted in the same manner as undertaken in relation to displacement (see 10.135 above).

Plot 10.5 Predicted impact range of a strong avoidance reaction of Sandeel and Herring/Sprat to piling around each WTG in the indicative layout. The small impact zone for Sandeel (solid red circles of 200m diameter) contrasts with the large range for Herring (open black circles of 28km diameter).



Barrier effects

10.143. Studies of the additional energetic costs of migratory species traversing around wind farms suggest these are negligible (Pettersson, 2005, Masden *et al.*, 2009). More significant barrier effects may occur where breeding species have to divert around a wind farm or wind farms multiple times during the course of a breeding season, assuming of course that they are displaced at all.

10.144. Current evidence suggests that amongst the seabirds, Gannet is likely to avoid entering wind farms but that gulls including Kittiwake may readily traverse wind farms (Petersen *et al.*, 2006, Krijgsveld *et al.*, 2011, Lindeboom *et al.*, 2011). However, such studies have not been conducted near to large breeding colonies for species such as Gannet, Kittiwake and auks and the response of breeding birds under energetic pressure to provision chicks may encourage a greater degree of risk-taking.

10.145. In the first instance of assessing barrier effects, it was assumed that under the worst case scenario that birds would indeed experience a barrier effect and be forced to deviate around an operational site. For the purposes of the assessment it was assumed that birds would experience barrier effects once the WTGs had been fully constructed (i.e. with blades) irrespective of whether they were actively turning, in line with the experimental study of Larsen & Guillemette (2007) on Eider. Conversely, the presence of turbine bases was assumed to offer no barrier to commuting birds.

10.146. For meaningful assessment of a barrier effect the direction and especially the origin and target location need to be established. In the first instance it is important to note that for a barrier effect to operate, the target must be at greater distance than the site. Otherwise, birds within the site are best treated within the assessment of displacement.

10.147. The process of compiling a case was begun through plotting of flight lines in boat-based surveys of breeding birds in the breeding season relative to the mean maximum foraging range. Tracking studies specific to FTOWDG (e.g. Daunt *et al.*, 2011a,b) as well as previous work (reviewed by Hamer *et al.*, 2011 and Daunt *et al.*, 2011) also provided a case for likely locations of foraging birds. In some cases the wider literature (e.g. Camphuysen, 2005, 2011) also provided supporting observations of birds in the wider area that provided insight into the foraging grounds of the species concerned. The output of this qualitative analysis was a plot outlining the likely origin and target location of commuting birds.

10.148. Once the locality was established, GIS was utilised to derive the least cost path from colony to foraging location and entirely avoiding either Project Alpha or Project Bravo separately as well as other sites in cumulative analysis. It was assumed a bird would take the most efficient route following an initial (short) period of learning. The procedure involved stipulating a study area inclusive of all wind farm sites in the Firth of Forth for cumulative purposes and converting this to a 100m raster grid. A theoretical bird would then move from cell to cell after within this grid, taking the least cost option in each cell according to the available cost surface and to fit with the overall least cost pathway. The cost surface was simply comprised of two types of cell with the cells in any wind farm site represented by a value of 1,000,000 to prevent birds entering, with all other accessible cells having an equal value of 1.

10.149. Using the Distance>Cost Distance tool in the Spatial Analyst add on in ArcGIS v.10.1, a cost distance surface was produced from the start and end points and the relevant cost surface. This allowed the extraction of the shortest distances from the start point to the destination points. The Distance>Cost Path function was then used to visualise the best single pathways for the individual destination points based on the different wind farm scenarios including Project Alpha and Project Bravo, separately and cumulatively and cumulatively with Inch Cape and Neart na Gaoithe (see 10.484 below).

10.150. The difference between the resultant pathway distances to each of the destination points and the straight-line distances each multiplied by two to incorporate a return journey was calculated to provide the potential additional flight distances for the individual scenarios.

10.151. The resulting deviation was then assumed to occur over each and every trip. The relationship between additional travel distance and its relative (%) increase for daily energy expenditure has previously been calculated for many species occurring in the Firth of Forth (Masden *et al.*, 2010). In the absence of the actual parameters of the straight-line relationship, each line was extrapolated graphically to encompass the range of additional distances travelled after deviation around any site (this is capped at 10,000m in the original publication)

10.152. It is implicitly assumed by Masden *et al.*, (2010) that the additional energetic costs of each trip are rapidly recovered, as there is no facility for the accumulation of cost over multiple trips over an extended breeding season. On one hand this appears to be reasonable in that metabolic rate (and thus energy expenditure) increases rapidly in less than ideal weather conditions. For example, for Fulmar, metabolic rate increased by >100% when mean wind speed decreased and the birds assumed flapping flight. Other species dependent on flapping flight may experience similar costs with a headwind. On the other hand, additional meals must be taken to compensate additional costs as otherwise stored energy in the form of fat would be depleted over time. The question is whether this is depleted to an extent that subsequently affects survival or even future breeding performance.

10.153. An experimental study on breeding Parasitic Jaeger (Arctic Skua) *Stercorarius parasiticus* has shown that adult survival (measured as return rate) was higher in pairs that had experienced supplementary feeding in the previous season compared to the control birds (no supplementary feeding). This indicated that in sub-optimal foraging conditions, individuals may jeopardise future breeding attempts by maintaining too high an effort (implying a loss of stored energy) in the current season (Davis *et al.*, 2005). Compensating for any additional energetic costs of barrier effects may be straightforward where resources are plentiful but less easy where prey stocks are depleted.

10.154. The magnitude of the effect of increased additional distance as a result of a barrier effect was broadly derived from Masden *et al.* (2010). This paper showed a series of coloured contours of the daily energy expenditure (DEE) resulting from the relationship between additional distances travelled against the number of trips per day. Orange and red contours were used for values of ~90% or more of daily energy expenditure, and thus >90% of DEE was assumed to have a significant cost, with other values scaled accordingly (Table 10.16). Masden *et al.*, (2010) state that the frequency that this may be experienced due to unfavourable weather conditions or years of poor resources, may be relatively high.

Table 10.16 Definition of the magnitude of the effect of an increase in daily energy expenditure resulting from barrier effects upon the sensitive receptors assessed in this chapter.

Magnitude	Definition
High	>90% increase in daily energy expenditure
Medium	61 to 89% increase in daily energy expenditure
Low	31 to 60% increase in daily energy expenditure
Negligible	0 to 30% increase in daily energy expenditure

10.155. The significance of any barrier effect for sensitive species was assessed from a combination of the sensitivity of the receptor and the magnitude of the effect (Table 10.16) in the standard matrix (Table 10.10).

Collision Risk Modelling

10.156. The potential annual mortality through collision with turbine blades is calculated using CRM based on the flight behaviour of individual seabird species. CRM used data recorded from boat-based surveys, details of bird morphology from the literature (see 10.375 below) and specifics of the Project Alpha and Project Bravo developments (i.e. details of WTGs and wind conditions).

10.157. The recently revised 'Band Model', developed by SOSS was used (Band 2011). The model has six stages to estimate the number of birds potentially colliding with turbine blades. The stages are:

- assemble data on the number of flights which are potentially at risk from the wind farm;
- estimate the potential number of bird transits through the rotors of the wind farm;
- calculate the probability of collision during a single bird rotor transit;
- multiply the above to yield the potential collision mortality rate, allowing for the proportion of time that the turbines are not operational, assuming current bird use of the site and that no avoiding action is taken;
- allow for the proportion of birds likely to avoid the wind farm; and
- express the uncertainty surrounding such a collision risk estimate.

10.158. The first two stages described calculate the passage rate through the swept area. This was achieved using the density of flying birds from snapshots and the proportion of flying birds at risk height, flight speed and any nocturnal activity for each species considered.

10.159. The Rochdale Envelope assumes that the range of heights of the lowest sweep of rotor blades above water surface would be between 26.1m and 42.7m in relation to lowest astronomical tide. It was therefore assumed that 26.1m was a minimum value, with birds below this height not at risk of collision. The flight height recorded in boat-based surveys in broad height categories (see 10.42 above) was of insufficient detail to classify the proportion of birds at risk in modelling. As a result the generic modelling study of Cook *et al. (*2011) as part of SOSS, that utilised data from 32 wind farm sites in which large numbers of flight records were compiled (e.g. *n* = 62,975 for Kittiwake from 26 sites and 44,851 for Gannet from 27 sites) was used to define the proportion of each species at risk height of >26.1 m, with no upper ceiling value (i.e. above the sweep of turbine blades) as for seabirds in particular, this was assumed to be of negligible importance.

10.160. Specific data on flight speed of many species is provided in Pennycuick (1997) and Alerstam *et al. (*2007). If information on the species of concern was absent from these publications, then the approach of using a closely related species as a surrogate was adopted.

10.161. The level of nocturnal activity of 26 North European seabird species reported in Garthe & Hüppop (2004) was ranked from 1 (hardly any activity at night) to 5 (much activity at night), although no species actually achieved the top score. Rank scores were translated into broad percentage classes from 0%, 25%, 50%, 75% and 100% for use in CRM unless more detailed information was available (e.g. from tracking studies).

10.162. Flight height, speed and nocturnal activity were used as generic values. Otherwise data was partitioned by month in accordance with the typical interval for surveys. For example, the number of daylight hours for each month is calculated within the model from the latitude of the respective site.

10.163. Passage rate is then reduced to a potential mortality rate by factoring in the probability of collision (stage iii) and the proportion of time the WTGs are estimated to be operational (stage iv). The collision risk factors were calculated using species-specific details (length, wing span and flight speed) of the birds in question and details of the WTGs including rotor diameter and maximum chord (Table 10.17) and mean rotation speed by month (Table 10.18) according to the predicted wind conditions on the site.

Table 10.17 Details of the WTGs used in the CRM for the Project Alpha and Project Bravo developments.

Number of WTGs	Nominal output (MW)	Number of blades	Pitch (degrees)	Rotor diameter (m)	Maximum chord length (m)
75	7 MW	3	10	167	5.4

Table 10.18 Estimated mean rotor speeds (rpm) by month for the 7 MW WTG that may be installed at Project Alpha and Project Bravo.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
11.2	10.9	10.8	10.5	10.2	10.3	10.1	10.0	10.7	11.0	11.1	10.9

10.164. The worst case scenario for each of Project Alpha and Project Bravo, involving the installation of 75 x 7 MW WTGs was modelled. However, the mean rotation speed by month derived from a 6 MW 126m rotor diameter WTG was used as this gave higher rotation speeds as the worst case scenario that would future-proof the assessment against turbines that may yet be developed that might still fit the parameters of the Rochdale Envelope. The operational time of the WTG on a monthly basis was set at 88% based on Vortex Hindcast data modelling undertaken by Seagreen assuming that turbines would not be operational at 7% of the time due to operational and maintenance issues, with wind speed below the turbine cut-in of 3m/s for 5% of the time. The time above cut-out speed was assumed to be negligible and not included in modelling.

10.165. Output of the model is a predicted mortality rate per month that is then summed across all months to provide an annual estimate of mortality rate. To derive a rate for birds within a specific period such as the breeding season, the totals for the relevant months may be added. To derive mortality for a specific part of the population, such as adults in the breeding season, the relevant mortality rate may simply be scaled according to the proportion of adults recorded in surveys. Accurate ageing of a number of species such as gulls and Gannet is routinely undertaken in surveys. Data is typically summed over a specific period (e.g. the breeding period) to maximise the sample size available and avoid bias of a small number of individuals aged in a particular month.

10.166. Similarly, the predicted mortality rate may be apportioned between different populations, such as those contained within specific breeding colonies (e.g. SPAs), if a case is made for the representation of particular populations within the dataset. For example, it may be assumed that individuals from a range of specified colonies may have an equal chance of occurrence and are represented within the sample that collide in the same proportion that they occur within the combined population. Alternatively, some weighting may be applied to birds from colonies that are physically closer thereby leading to greater representation of individuals originating from such colonies in the fraction subject to collision.

10.167. Spatial variation in collision risk was also determined by modelling individual collision risk for relevant breeding species according to survey and within each snapshot during their breeding season. Each snapshot in the breeding season in either year was treated as an independent sample for the purposes of generating a 'collision risk surface'. Data pertaining to flying birds in snapshots, for each of the species and from each of the relevant surveys was filtered from the main database. From the count data in each snapshot, densities of birds were calculated by scaling to the area surveyed by a snapshot (0.141km^2). The Band model (see 10.157 above) was used to provide an estimated number of collisions with turbines based on the densities of birds seen in a specific snapshot and using relevant bird and wind farm parameters (see 10.158 & 10.163 above). The model was run for each snapshot using a single turbine, as this was deemed most appropriate given the area surveyed. The models assumed a 98% avoidance rate for all of the bird species.

10.168. A collision risk index was then produced after conversion of each of the individual snapshot collisions to a percentage of the maximum number of collisions per snapshot for each species. Thus, the results represented a scale from lowest to highest risk of collision at each snapshot location during each survey in the breeding season.

10.169. Collision risk index maps were plotted for each of the species, using graduated circles centred on the snapshot locations. A surface map was then interpolated from these data using Inverse Distance Weighting (IDW) in ArcGIS v10.1. This method of interpolation allows for high spatial autocorrelation within the datasets and produces reliable surfaces and is also easily replicated. The value of the closest 20 records was used to calculate every interpolated point, with those closer allocated higher weighting. Note that these data are only used for visual representation of observations and are not directly included in any further analyses.

10.170. Records of feeding activity at any location of the line transect were also plotted on the maps to aid interpretation of patterns as it was thought that large feeding aggregations could help explain any clusters of collision risk, bearing in mind that data in snapshots may not entirely reflect abundance of birds in line transect.

Transmission Asset Project

10.171. Assessment of components of the Transmission Asset Project followed the methodology given above for displacement, indirect effects and barrier effect. Collision effects with structures such as OSPs are not considered likely to be significant and thus, collision risk modelling was not carried out for the Transmission Asset Project.

EXISTING ENVIRONMENT

Aerial surveys

10.172. A total of 91,737 birds from 26 identified species (and 15 unidentified taxa) were observed in the aerial surveys of the Firth of Forth. Auks were the dominant group, representing 59% of the total observations (99.9% were unidentified). Gulls represented 21.2% of the total observations, with Kittiwake contributing 74% of the gulls recorded. Gannet was the most frequently identified species.

10.173. DISTANCE analysis of the dominant group, auks, showed considerable variation between the summer and winter and between surveys within each period. Peak estimates for the four species / taxonomic group are provided in Table 10.19. These are generally in keeping with expectations and estimates from other studies (e.g. Stone *et al.*, 1995, Skov *et al.*, 1995).

Table 10.19 Peak DISTANCE corrected density and population estimates from the summer and winter periods derived from aerial surveys of the Firth of Forth.

Species / Group	Period	Density (ind./km^2)	Population
Auks	Summer	25.980	149,502
	Winter	13.516	94,708
Northern Gannet	Summer	4.728	27,207
	Winter	0.366	2,106
Black-legged Kittiwake	Summer	4.629	26,638
	Winter	2.726	15,687
Gulls (excluding Kittiwake)	Summer	0.732	4,212
	Winter	1.161	6,681

10.174. Distribution maps for the dominant auks revealed that the species group were distributed throughout the region during both the summer and winter, but were selecting areas to the south of the Project Alpha and Project Bravo development sites. These areas correspond to Marr Bank and Wee Bankie, areas known to be important for seabirds (Camphuysen 2005, Kober *et al.*, 2009).

10.175. Jacob's selectivity index of the aerial surveys revealed that no species or taxonomic group specifically selected (D > +0.50) either Project Alpha or Project Bravo in either summer, winter or overall. However, Herring Gull showed meaningful avoidance (D > -0.50) of both Project Alpha (D = -0.81) and Project Bravo (D = -0.89) that stemmed from avoidance in the winter period (D = -0.72 and -0.84 for Project Alpha and Project Bravo respectively).

10.176. In relation to the STW sites, Inch Cape was generally neither selected nor avoided with only Kittiwake showing any particular selection by avoiding the site in the summer months (D = -0.59). In contrast, both Lesser Black-backed Gull (D = +0.60) and Herring Gull (D = +0.63) selected Neart na Gaoithe in the summer period, which underpinned overall positive selection for Lesser Black-backed Gull (D = +0.52). This selection may have been caused by the relative proximity of this site to the Forth Islands SPA where large numbers of both these gull species breed. The pattern of selection of gulls for Neart na Gaoithe did however continue in the winter months, with selection by Great Black-backed Gull (D = +0.52).

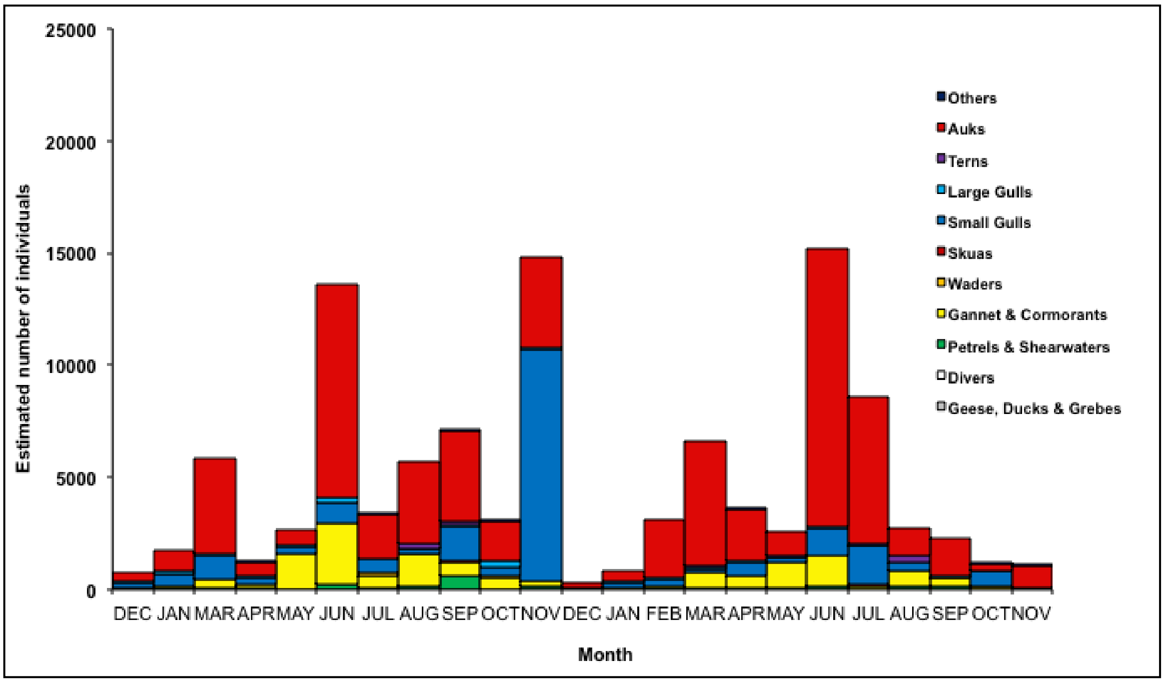
Boat-based surveys

Project Alpha

10.177. A total of 24,206 individual birds of 39 identified species (and 10 unidentified taxa) were recorded by boat-based surveys within the Project Alpha development boundary. Guillemot (28.1%), Kittiwake (24.8%) and Gannet (16.1%) were the most numerous species recorded. Auks in general dominated the assemblage throughout the year.

10.178. Overall, the numbers of birds were lowest in the winter between December to February, increasing in March as birds returned to colonies. Numbers varied during the breeding season, though June registered peak numbers in both 2010 and 2011. Numbers of birds decreased during the passage/ dispersal period, with the exception of November 2010, when a large population of Kittiwake was recorded (Plot 10.6). Many of these birds were recorded in foraging aggregations.

Plot 10.6 Estimated number of individuals and relative abundance of different taxonomic groups of birds in each survey month derived from boat-based surveys of Project Alpha between December 2009 to November 2011. The number of individuals is estimated from standard methodology of combining the density of birds on the water (line transects) and flying birds (snapshots).



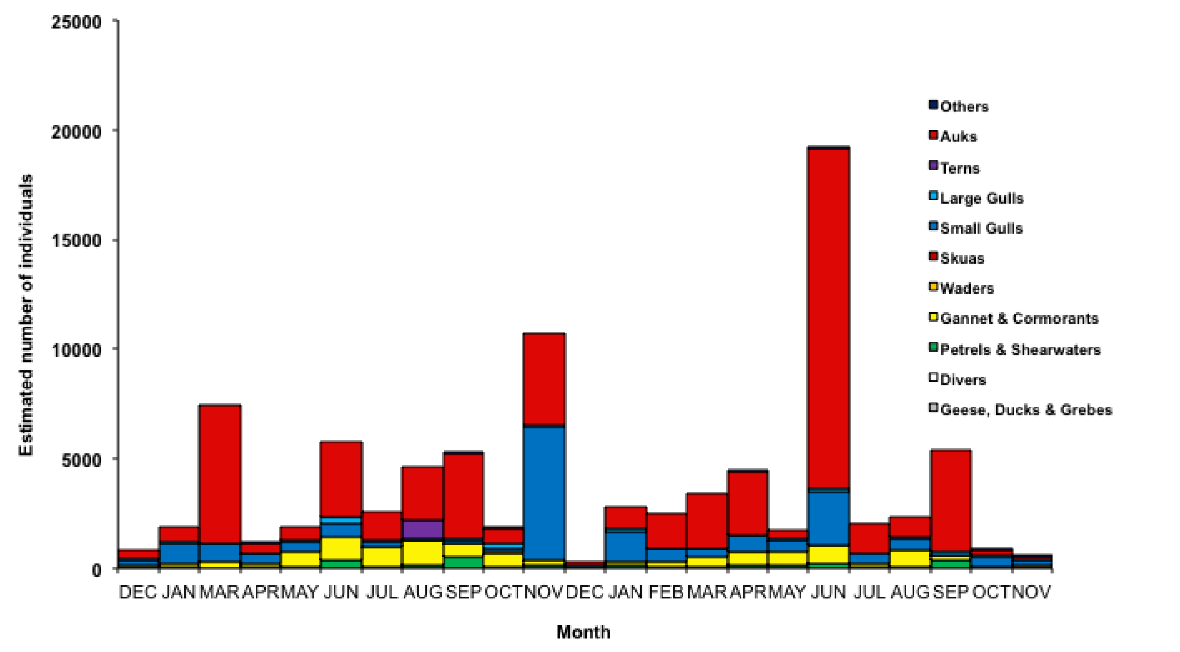
10.179. There was a relatively even distribution of all flying birds recorded within the Project Alpha development site, with most areas supporting on average 5 to 25 individuals per km^2 surveyed. In contrast, the distribution of birds on the water was more patchy with some suggestion of areas closer to shore on the western side of Project Alpha supporting greater density with many cells supporting >10 individuals/ km^2 on average interspersed with hotspots of >50 and even >100 individuals/ km^2.

Project Bravo

10.180. Boat-based surveys recorded 20,436 birds from 37 species (and seven unidentified taxa) in Project Bravo in the 23 surveys during the study period. Similar to Project Alpha, Guillemot (29.3%), Kittiwake (21.6%) and Gannet (16.6%) were the dominant species in numerical terms. As in Project Alpha, auks dominated the assemblage throughout the two-year study period (Plot 10.7)

10.181. The seasonal pattern was similar to Project Alpha, with the lowest number of birds recorded in the winter (December to February) increasing in March and fluctuating during the breeding season and passage period. The peak month of the breeding season was June in both 2010 and 2011, although this was considerably higher in 2011 as a result of a high population estimate of >12,000 Guillemots. The number of Kittiwake present in Project Bravo in November 2010 was generally not as high as Project Alpha but the numbers were sufficient to create the highest estimate of 2010 in late autumn (November) when large feeding aggregations were recorded (Plot 10.7).

Plot 10.7 Estimated number of individuals and relative abundance of different taxonomic groups of birds in each survey month derived from boat-based surveys of Project Bravo between December 2009 to November 2011. The number of individuals is estimated from standard methodology of combining the density of birds on the water (line transects) and flying birds (snapshots).



10.182. The distribution of flying birds within Project Bravo was relatively uniform, with most 1km^2 grid cells supporting 5 to 25 individuals/ km^2 on average. A number of hotspots of birds on the water with densities of >50 individuals/ km^2 were recorded centrally within Project Bravo suggestive of consistent association with a particular habitat feature rather than specific aggregation for some reason on one occasion.

Sensitive Receptors

10.183. Sensitive species were identified using the three criteria set out in 10.93 above resulting in 29 species for initial consideration in relation to Project Alpha and 27 species for consideration in relation to Project Bravo. The sensitive species included the three species of geese and 13 species of wader to be considered as part of the HRA process at the request of the SNCBs.

10.184. Predicted mortality of all sixteen species of waterfowl was <0.01% of the known respective wintering populations of Great Britain and Ireland and thus was regarded as negligible for the purposes of EIA and these species were not brought into this ES for further consideration. Further investigation of the specific impacts upon individual SPAs may however be required according to HRA.

10.185. Thirteen species of seabird - Fulmar, Sooty Shearwater *Puffinus griseus*, Gannet, Kittiwake, Lesser Black-backed Gull, Herring Gull, Great Black-backed Gull, Common Tern *Sterna hirundo*, Arctic Tern *S. paradisaea*, Guillemot, Razorbill, Little Auk and Puffin - all occurred in at least regionally important numbers within Project Alpha. The same species were represented at Project Bravo with the exclusion of Sooty Shearwater, Lesser Black-backed Gull and Common Tern.

10.186. Considering the relative proximity of the Projects to a number of internationally important seabird colonies, meaning that they fell within range of >750,000 breeding individuals (see 10.7 above), it is somewhat surprising that only one species –Razorbill - occurred in nationally important numbers in the breeding season, with this being restricted to Project

Alpha. Puffin however occurred in internationally important numbers in the context of the North Sea in winter in both Projects.

10.187. In total, eight species of seabird - Fulmar, Gannet, Kittiwake, Lesser Black-backed Gull, Herring Gull, Guillemot, Razorbill and Puffin – were linked to one or more of four SPAs. Thus, Lesser Black-backed Gull was also considered to be sensitive at Project Bravo even though not occurring in important numbers. Eleven species of seabird were therefore initially considered to be sensitive in Project Bravo.

10.188. Based on the principles established by the IEEM (2010) (see 10.183 above), several of the initial sensitive species were screened out of this ES. These were Fulmar, Sooty Shearwater, Common Tern and Little Auk. The species considered in this ES were therefore mainly breeding species. Whilst Great Black-backed Gull is mainly a wintering species, it was the potential for persistence of the small numbers of local breeders throughout the year that was of particular concern. The only passage species requiring further consideration was Arctic Tern.

10.189. No species was to be considered at a single site in isolation. The combination of species and the effects with the potential for significant ecological impact, are illustrated in Table 10.20. The nine species represented in broad order of concern were Kittiwake, Gannet, Guillemot, Razorbill, Puffin, Herring Gull, Great Black-backed Gull, Lesser Black-backed Gull and Arctic Tern.

Table 10.20 Species with the potential to be subject to significant ecological impact as a result of the four effects to be considered in EIA for both Project Alpha and Project Bravo.

Species	Potential effects			
	Collision	Displacement	Barrier Effects	Indirect effects
Northern Gannet	•		•	
Black-legged Kittiwake	•	•	•	•
Lesser Black-backed Gull	•			
European Herring Gull	•			
Common Guillemot		•	•	•
Razorbill		•	•	•
Atlantic Puffin		•	•	•
Great Black-backed Gull	•			
Arctic Tern				•

10.190. Only Kittiwake was to be considered in relation to all four possible effects, with the assessment upon auks to focus on displacement, barrier effects and indirect effects. In contrast, collision was of primary concern for the large gulls and Gannet. The potential for barrier effects upon Gannet was also of secondary concern. For Arctic Tern, only indirect effects were to be assessed.

10.191. Although each species tended to occur in more than one phenological period, concern was focused on the fraction of breeding individuals from one or more colonies, even if this was small. For example, small numbers of breeding Herring and Lesser Black-backed Gulls may be associated with SPAs. Similarly, a small number of breeding Great Black-backed Gull may persist throughout the year, even when the population is swollen by immigrants in the winter period (Forrester *et al.*, 2007). The larger population present in the winter mainly from other

European countries was not of specific concern. The potential linkage of each species to particular colonies is summarised in Table 10.21. Only Arctic Tern was of no concern as a breeding species as the birds were primarily recorded in the (autumn) passage period and the colonies were beyond foraging range of Project Alpha and Project Bravo.

Table 10.21 Potential linkage of sensitive breeding species recorded in Project Alpha and Project Bravo with particular colonies in broad order of importance, as derived from the size and distance of colonies of records and flight direction data and specific tracking of a few species.

Species	Likely origin in the breeding season
Northern Gannet	Forth Islands SPA (Bass Rock SSSI)
Black-legged Kittiwake	Fowlsheugh SPA, Forth Islands SPA (Forth Islands SSSI, Isle of May SSSI, Bass Rock SSSI)
Lesser Black-backed Gull	Forth Islands SPA (Forth Islands SSSI, Inchmickery SSSI, Bass Rock SSSI), non-designated colonies
European Herring Gull	Fowlsheugh SPA, non-designated colonies, Forth Islands SPA (Forth Islands SSSI, Inchmickery SSSI, Bass Rock SSSI)
Common Guillemot	Fowlsheugh SPA, non-designated colonies,
Razorbill	Fowlsheugh SPA, non-designated colonies, Forth Islands SPA (Forth Islands SSSI, Bass Rock SSSI)
Atlantic Puffin	Forth Islands SPA (Isle of May SSSI, Forth Islands SSSI, Bass Rock SSSI), non-designated colonies
Great Black-backed Gull	Isle of May, Forth Islands SSSI (especially Craigleith), non-designated colonies

10.192. The likely strength of linkage between a particular colony and Project Alpha and Project Bravo was surmised from a discussion of the relative size and distance of colonies coupled with evidence of flight direction and especially specific tracking data where this was available (see Baseline Technical Report - Volume III Appendix F1 for further details).

10.193. The sensitivity classification of the breeding species, based on the linkage between the breeding species and designated colonies (see Tables 10.7 and 10.21) is shown in Table 10.21. Arctic Tern was afforded Medium sensitivity as an Annex 1 species as well as occurring in regionally important numbers (Table 10.22).

10.194. In addition, Razorbill and Puffin also achieved High sensitivity for nationally important numbers during the breeding and wintering periods respectively, whereas the others all occurred in regionally important numbers in one or more phenological periods.

Table 10.22 Sensitivity classifications of the sensitive receptors.

Species	Sensitivity
Northern Gannet	High
Black-legged Kittiwake	High
Lesser Black-backed Gull	High
European Herring Gull	High
Common Guillemot	High
Razorbill	High
Atlantic Puffin	High
Great Black-backed Gull	Medium
Arctic Tern	Medium

10.195. An outline of the sensitive receptors in broad order of concern is provided below with full details within the accompanying Baseline Technical Report (Volume III Appendix F1). The order of concern is Kittiwake, Gannet, Guillemot, Razorbill, Puffin, Herring Gull, Great Back-backed Gull, Lesser Black-backed Gull and Arctic Tern.

Black-legged Kittiwake

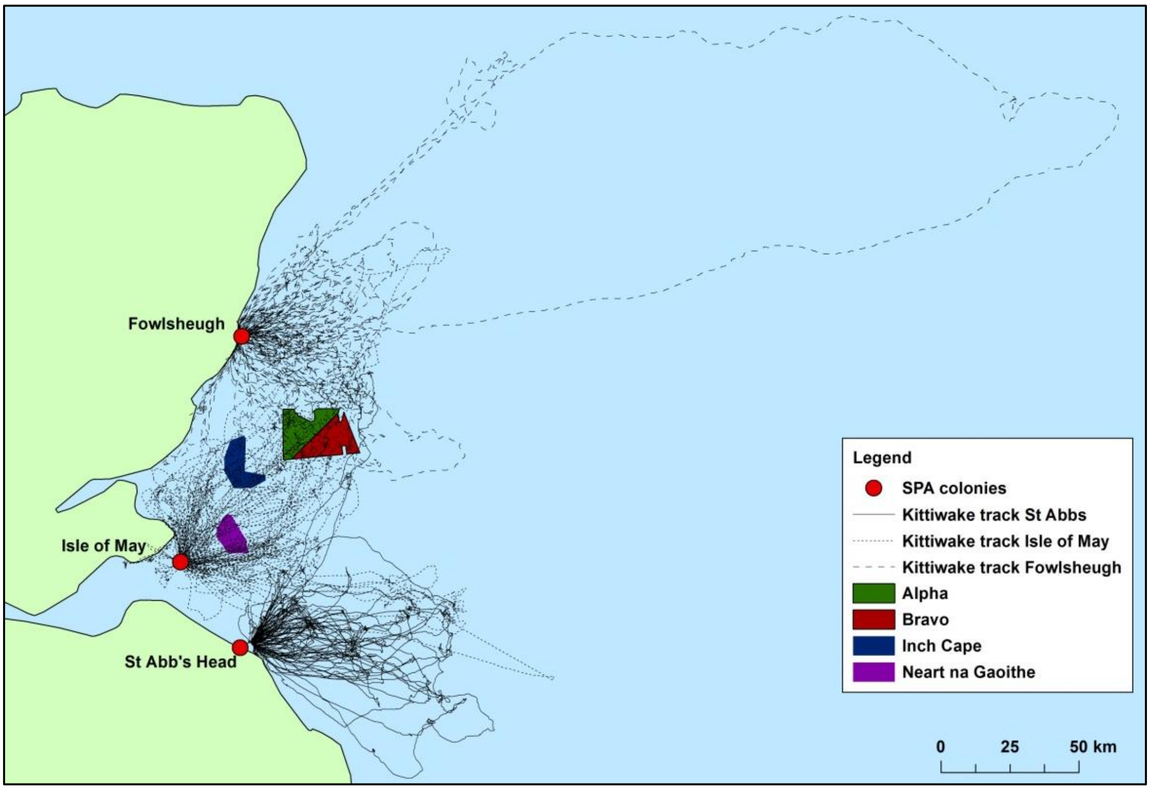
10.196. Kittiwake is the most numerous gull in the world with approximately 2.7 million breeding pairs (Coulson, 2011). In Europe the species is evaluated as Secure (BirdLife International 2004) whereas in the UK, Kittiwake is of Amber conservation concern in part due to population decline over the last 25 years (Eaton *et al.*, 2009).

10.197. The breeding population of the UK declined by 25% from 1988 until Seabird 2000 when 378,847 pairs were recorded. A further 30% decline was recorded between 2000 and 2010 (JNCC, 2011). More northerly colonies especially those in Scotland suffered the greatest declines. Numbers of Kittiwakes at Fowlsheugh SPA - the closest SPA colony to Project Alpha and Project Bravo at 30km - decreased by 40% in the decade to 2010. The prevailing factor in decline is thought to be a change in the availability of prey, particularly sandeels.

10.198. With 28,386 individuals (2009), (SMP JNCC, 2011), Fowlsheugh SPA still supports the greatest number of Kittiwakes within the mean maximum foraging range (60km – Thaxter *et al.*, 2012) from the Projects. Other important colonies include The Forth Islands SPA with 5,370 individuals. Extending the foraging range to 83.3km to include one standard deviation brings Buchan Ness to Collieston SPA (28,266 individuals in 2007) and St. Abb's Head to Fast Castle SPA (18,136 individuals in 2011) into range of the Projects.

10.199. Specific tracking studies suggested there was very little prospect of birds from outside mean maximum range reaching Project Alpha and Project Bravo, with only one exceptional individual from Fowlsheugh undertaking an extremely long-ranging foraging trip (Plot 10.8). Equally, only one bird on one trip reached Project Bravo from St Abbs Head.

Plot 10.8 Tracklines of breeding Kittwakes fitted with GPS tags from Isle of May (*n* = 36) in 2010 and Fowlsheugh (*n* = 35) and St Abbs Head (*n* = 25) in 2011.



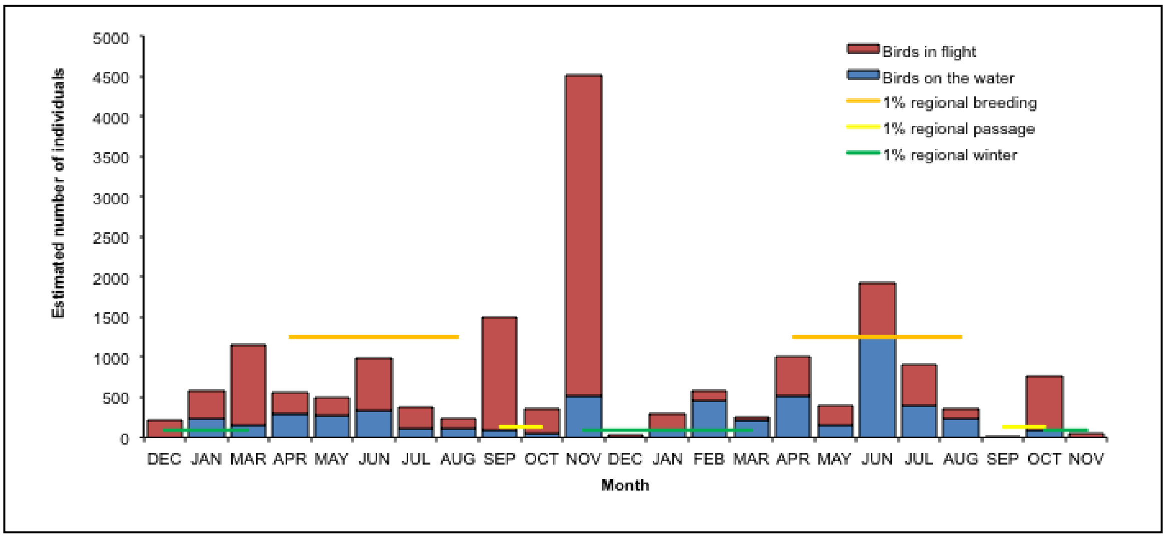
10.200. Moreover, despite Fowlsheugh SPA being closer in terms of distance, there was a slightly higher likelihood of Kittiwakes from the Isle of May (Forth Islands SPA) reaching the Projects. Of the 91 trips from the Isle of May by tagged birds, 15% reached Project Alpha with 12% reaching Project Bravo (c.f. 23% and 32% across Inch Cape and Neart na Gaoithe respectively). From Fowlsheugh, 10% of 93 trips reached Project Alpha with 6% reaching Project Bravo (c.f. 2% and 0% across Inch Cape and Neart na Gaoithe respectively).

10.201. The kernel analysis by Daunt *et al.* (2011a,b) suggested that the core areas of use by Kittiwakes from the Isle of May did not include much of Project Alpha and only clipped the western and southeastern corner of the site. Similarly only the very edge of the southeastern corner of Project Bravo was incorporated in the core area. For Kittiwakes from Fowlsheugh, only the northwest corner of Project Alpha was incorporated within the core area, with Project Bravo falling entirely outwith the core.

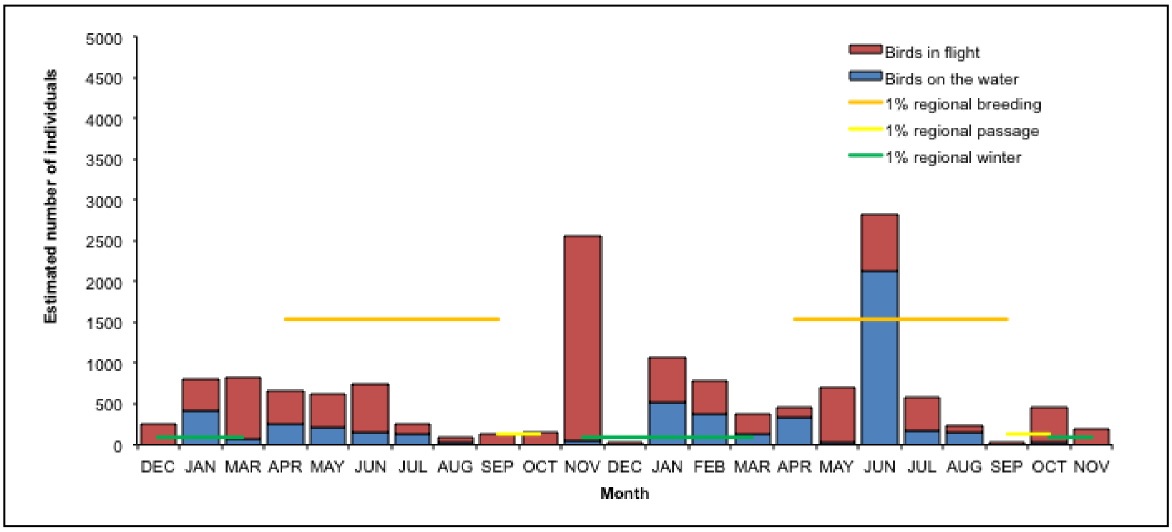
10.202. For simplicity, if it is assumed that there is a broadly equal chance (10-15%) of Kittiwakes from the Isle of May or Fowlsheugh reaching Project Alpha, the respective sizes of the colonies suggests that a greater proportion of the birds observed within the site boundary originate from Fowlsheugh (52%) compared to the Isle of May (10%) and other colonies. This was further supported by the prominent southeast - northwest flight axis recorded in boat-based surveys during the breeding season. Although tracking suggested a reduced prominence of birds from Fowlsheugh relative to the Isle of May within Project Bravo, this was not borne out by flight direction, which was again dominated by a southeast - northwest flight axis. Interestingly, potential flights from the Fowlsheugh were recorded almost twice as frequently as return flights.

10.203. That the core foraging areas for Kittiwakes from both Fowlsheugh and the Isle of May lie outside Projects Alpha and Bravo is reflected in the population estimates during the breeding season. During the breeding season, the great majority of birds recorded were adults in both Project Alpha (94% of an aged sample of *n* = 1122) and Project Bravo (96% of *n* = 1118). In only the June 2011 survey were regionally important numbers (criterion of 1,247 individuals) recorded in Project Alpha (1,883 individuals) and Project Bravo (2,763 individuals) as shown in Plots 10.9 and 10.10 respectively. The bulk of the birds in both sites in June 2011 were recorded on the water contributing to DISTANCE corrected densities and populations of 1,249 birds in Project Alpha (global model) and 2,132 birds in Project Bravo (individual model).

Plot 10.9 Kittiwake population estimates by month derived from boat-based surveys of Project Alpha. Estimates are derived from DISTANCE corrected densities for birds on the water and from snapshots for flying birds. The 1% criteria for regionally important populations are shown.



Plot 10.10 Kittiwake population estimates by month derived from boat-based surveys of Project Bravo. Estimates are derived from DISTANCE corrected densities for birds on the water and from snapshots for flying birds. The 1% criteria for regionally important populations are shown.



10.204. The threshold for the passage period was exceeded in both September and October 2010 and October 2011 at both sites. The peak population in 2010 was recorded in November, which within Project Alpha was substantially higher than any other estimate during the study period (Plot 10.9).

10.205. The clear links to the Fowlsheugh and Forth Islands SPA colonies to the north and south of Project Alpha and Project Bravo strengthened the argument for Kittiwake as a sensitive receptor promoted by its relative vulnerability to collision (6th of 37 species according to Furness & Wade, 2012) despite its high manoeuvrability. Cook *et al. (*2011) derived a proportion of 16.1% of flights >20m by Kittiwake, which was replicated by data from Project Bravo (15.7%), although the estimate from Project Alpha was slightly lower (10.7%). The proportion of birds in flight coupled with flight altitude meant that the potential for a significant ecological impact upon breeding birds in particular could not be discounted.

10.206. Kittiwake is not thought to be vulnerable to displacement from wind farms with a rank of 24th of 37 seabirds according to Furness & Wade (2012). There was evidence that the sites, particularly near to Scalp Bank in the west, were used as foraging grounds with 37% of all birds recorded exhibiting direct feeding behaviours within the Project Alpha boundary, with 26% recorded in Project Bravo, although the bulk of this activity was outside the breeding season.

10.207. However, the use of the area by breeding birds from SPA colonies that are in decline, coupled with the dependence of Kittiwake upon specific prey such as sandeels, the availability of which may be limited in space and time all reinforced the view that displacement, including barrier effects and the indirect effects on prey through construction were best considered within this ES chapter.

Northern Gannet

10.208. The global population of Gannet has shown a long term increase and range expansion, with recent estimates of 418,000 pairs (Wanless *et al.*, 2005). Europe supports 75% of the global population and is considered 'Secure' (BirdLife International 2004). In the UK, Gannet numbers continue to increase although it is of 'Amber' conservation concern as a result of localisation in a few breeding sites (Eaton *et al.,* 2009).

10.209. In 2009, Bass Rock supported 55,482 breeding pairs, which is the second largest colony in the east Atlantic (Murray, 2011). Bass Rock (also a SSSI) is part of the Forth Islands SPA is located within ~65km of Project Alpha and Project Bravo well within foraging range. Only one other colony in the Gamrie and Pennan Coast SSSI (5,574 individuals in 2010) is present within mean maximum foraging range of 229.4km (Thaxter *et al.*, 2012) from the Projects. Further colonies are present within mean maximum foraging range with one standard deviation (353.7km – Thaxter *et al.*, 2012) including Fair Isle SPA, Flamborough Head and Bempton Cliffs SPA.

10.210. A prominent flight axis of northeast-southwest was recorded at both Project Alpha (70% of flights during the breeding season) and Project Bravo (65%), corresponding with flights to and from Bass Rock. Most, if not all, adult birds recorded during the breeding season (April to September) are thus assumed to originate from the SPA colony, which concurs with the view of Hamer *et al. (*2011) that it is very unlikely that birds from colonies other than Bass Rock will occur in the Forth in the breeding season.

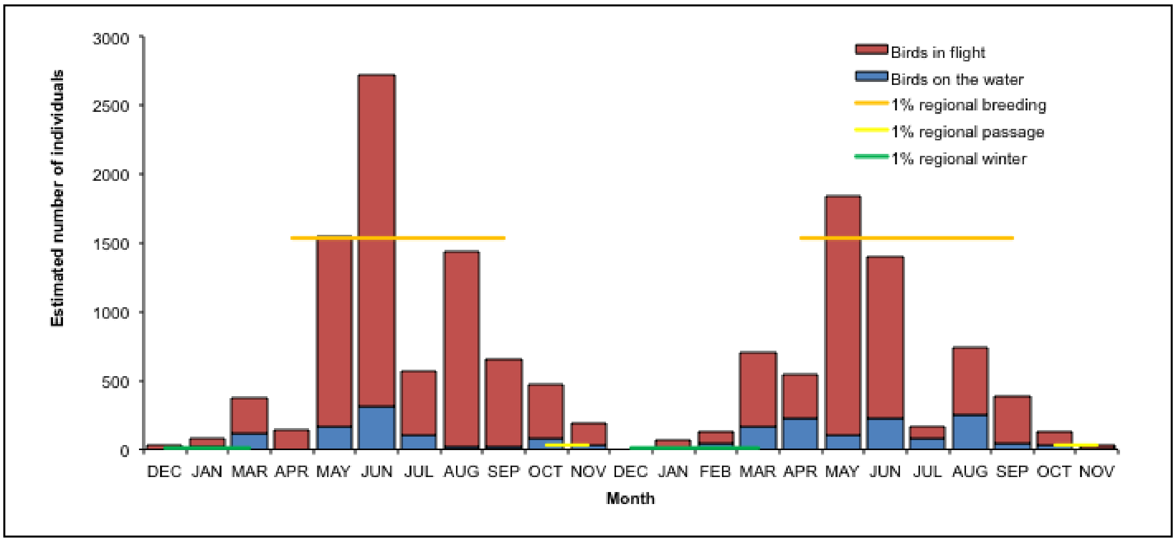
10.211. During the winter, more than 80% of Gannets tracked from Bass Rock migrated south and overwintered off West Africa and in the Mediterranean Sea (Kubetzki *et al.*, 2009). Birds present during the passage period and winter could originate from any of the colonies considered within foraging range in the breeding season, as well those from further afield including Shetland and even Norway as birds migrate southwards.

10.212. With the relative proximity of Bass Rock to Project Alpha and Project Bravo, Gannet were ever present in both development areas throughout the study period and numbers of birds were relatively consistent between years (Plots 10.11 & 10.12). The regional threshold

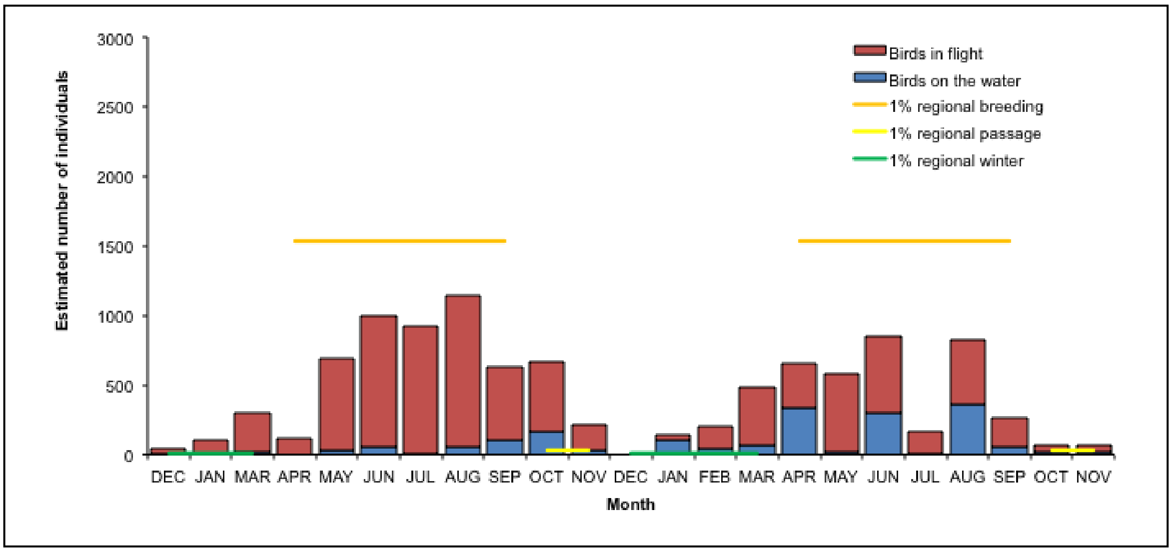
(1,530 individuals) during the breeding season was exceed on three occasions in Project Alpha, May and June in 2010 and May in 2011 (Plot 10.11).

10.213. In contrast, the regional threshold during the breeding season was not exceeded at Project Bravo, although greater numbers were recorded during the breeding season that at other times of year. In both Project Alpha and Project Bravo, adults dominated the pool of birds in the breeding with 97% (of an aged sample of *n* = 2,299) and 98% (from *n* = 1,895). The inclusion of Gannet as a sensitive species for Project Bravo was thus primarily due to the link with Bass Rock, rather than as a result of population estimates.

Plot 10.11 Gannet population estimates by month derived from boat-based surveys of Project Alpha. Estimates are derived from standard techniques using line transects and snapshots for flying birds. The 1% criteria for regionally important populations are shown.



Plot 10.12 Gannet population estimates by month derived from boat-based surveys of Project Bravo. Estimates are derived from standard techniques using line transects and snapshots for flying birds. The 1% criteria for regionally important populations are shown.



10.214. Densities were generally lower in Project Bravo compared to Project Alpha in the breeding season reaching 6-9 individuals/ km^2 at peak, which accords with the range to >10 individuals/ km^2 presented by Camphuysen (2011) in the Firth of Forth. Peak densities of this magnitude are substantially higher than several other areas of importance in the North Sea (e.g. North Shetland and Orkney at <2 individuals/ km^2) derived by Skov *et al.* (1995), but this is not surprising given the proximity of Bass Rock to the Projects.

10.215. Distribution maps of Gannets in flight derived from boat-based surveys revealed no particular selection of an area of either Project Alpha or Project Bravo regardless of year or period (breeding or winter). Aerial surveys of the region during the summer, revealed higher concentrations of Gannet across a central band corresponding to the northeast-southwest flight axis from Bass Rock and the Wee Bankie and Marr Bank complex.

10.216. Gannet is considered to be vulnerable to collision with turbines due to the amount of time spent in flight the proportion of flights at risk height and relatively low flight manoeuvrability (Garthe & Hüppop, 2004, Furness & Wade, 2012). A high proportion of Gannets were observed in flight at both at Project Alpha (85%) and Project Bravo (83%). At Project Alpha, 9.4% of the 3,303 flights were above 20 m, whilst at Project Bravo the proportion of 2,813 flights above 20m was higher at 16.3%. The latter corresponds closely to that modelled by Cook *et al.* (2011) of 16.8%. Vulnerability and the link to Bass Rock reinforced the selection of Gannet as a sensitive receptor for both Project Alpha and Project Bravo in relation to collision risk.

10.217. Gannet is however, not considered to be vulnerable to displacement, being ranked 28th from 37 Scottish seabirds by Furness & Wade (2012). There was little evidence that either site was an important foraging ground with just 3.9% and 3.7% of Gannets observed feeding within Project Alpha and Bravo respectively. The feeding records were generally isolated individuals or small aggregations, patchily distributed across both sites. Neither displacement nor indirect effects were considered to have the potential to have a significant ecological impact on a population scale and therefore were not assessed as part of this ES chapter.

10.218. Birds commuting to and from Bass Rock from and to and from foraging areas at Halibut Bank and Buchan Deep (Camphuysen, 2011) and Fladen Ground (see Hamer *et al.*, 2011) in a more or less direct line to the north and north-west of the Projects, meant that there was potential for significant ecological impact through increased energy expenditure (see Masden *et al.*, 2010, McDonald *et al.*, 2012) should birds avoid the wind farms, as seems likely (Krijgsveld *et al.*, 2011). Displacement through barrier effects was therefore considered in this ES chapter.

Common Guillemot

10.219. Guillemot is one of the more abundant seabirds, with a world population exceeding seven million pairs (Mitchell *et al.*, 2004). The European population of over two million pairs is classed as Secure (BirdLife International, 2004). The UK holds 1,420,000 birds (12.9% of the global population) but is of Amber conservation concern due to internationally important numbers at ten or fewer colonies (JNCC, 2011, Eaton *et al.*, 2009). The number of Guillemots is now at its highest since the first census in the 1960s (JNCC, 2011).

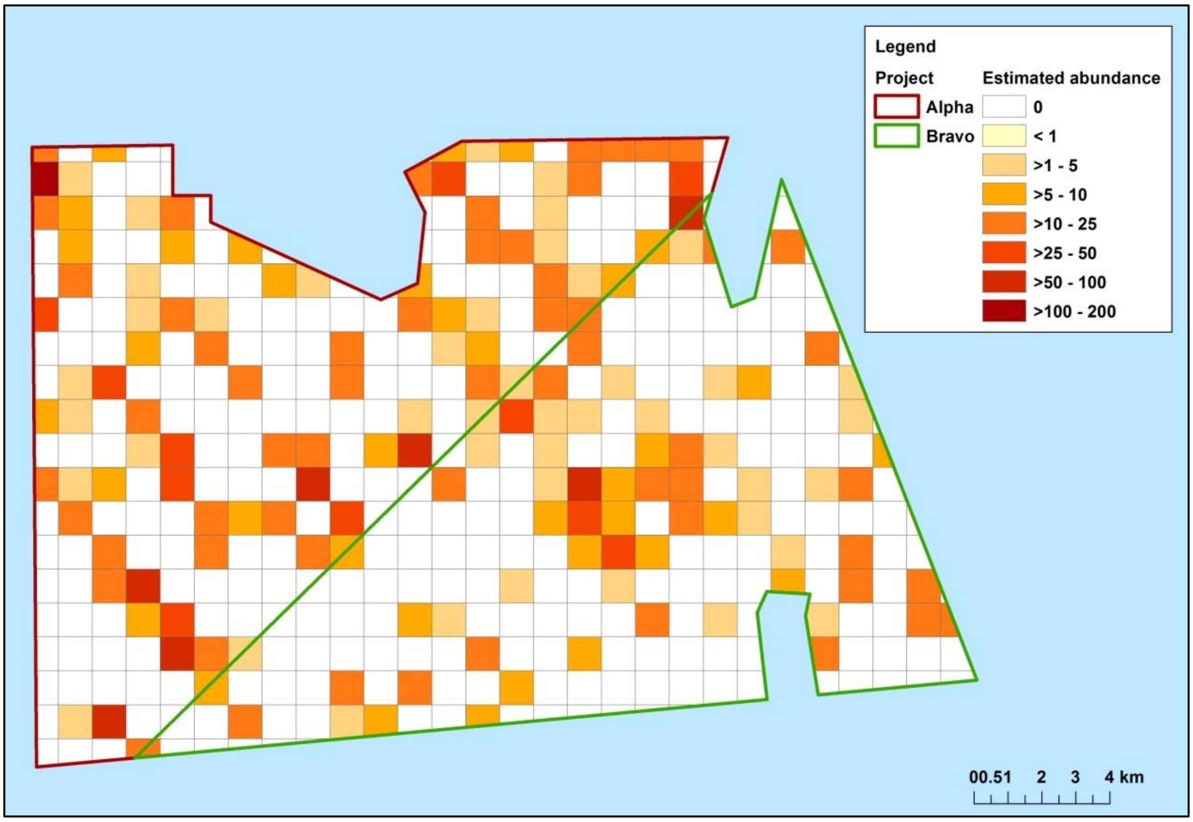
10.220. Both Project Alpha and Project Bravo are within potential foraging range (mean maximum of 84km) of four SPA colonies comprised of Fowlsheugh SPA (30km), Forth Islands SPA (66km with the Isle of May being closer), St. Abb's Head to Fast Castle (68km) and Buchan Ness to Collieston Coast SPA (82km). Fowlsheugh is by far the largest colony with 50,556 individuals in 200. Indeed, at the time of the last national census in Seabird 2000 it was the third largest colony in Britain and Ireland. In comparison the Forth Islands supported 23,798 individuals in 2011.

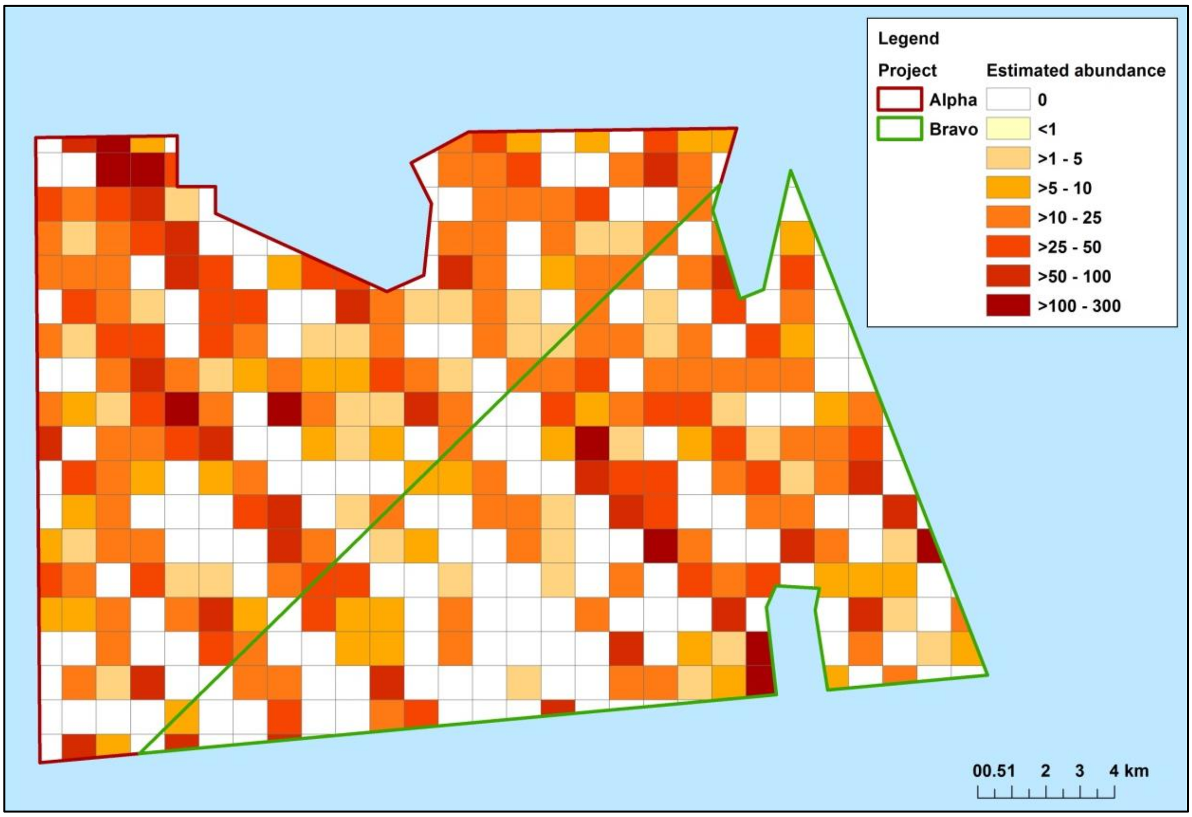
10.221. No Guillemot tracked from the Isle of May within the Forth Islands by Daunt *et al.* (2011a) reached either Project Alpha or Project Bravo in 2010. Inter-annual variation in the extent of foraging range is known to occur with birds travelling further in years with depleted resources. However, even in poor years it would appear that Project Alpha and Project Bravo remain at the extremity of range for Guillemots from the Isle of May (Daunt *et al.*, 2011c). Data from trip durations of Guillemots breeding at Fowlsheugh and St Abb's Head concluded that the mean maximum range was just 12km at Fowlsheugh and 16km at St Abb's Head, with a maximum range of 55km at both colonies (Daunt *et al.*, 2011b). Project Alpha and Project Bravo are thus within range of Fowlsheugh. However, boat-based survey data showed considerable inter-annual variation in density, suggesting that use of the sites, especially Project Bravo, may vary between years (Plot 10.13).

10.222. Guillemot was recorded in all surveys of both Project Alpha and Project Bravo over the two-year study period. A similar pattern of abundance was recorded in both Project Alpha and Project Bravo, with a peak immediately prior to the breeding season in March as birds return to the colonies (Plots 10.14 & 10.15). Adult birds dominated the population during the breeding season in both Project Alpha (85% from n = 300) and Bravo (72% from n =160).

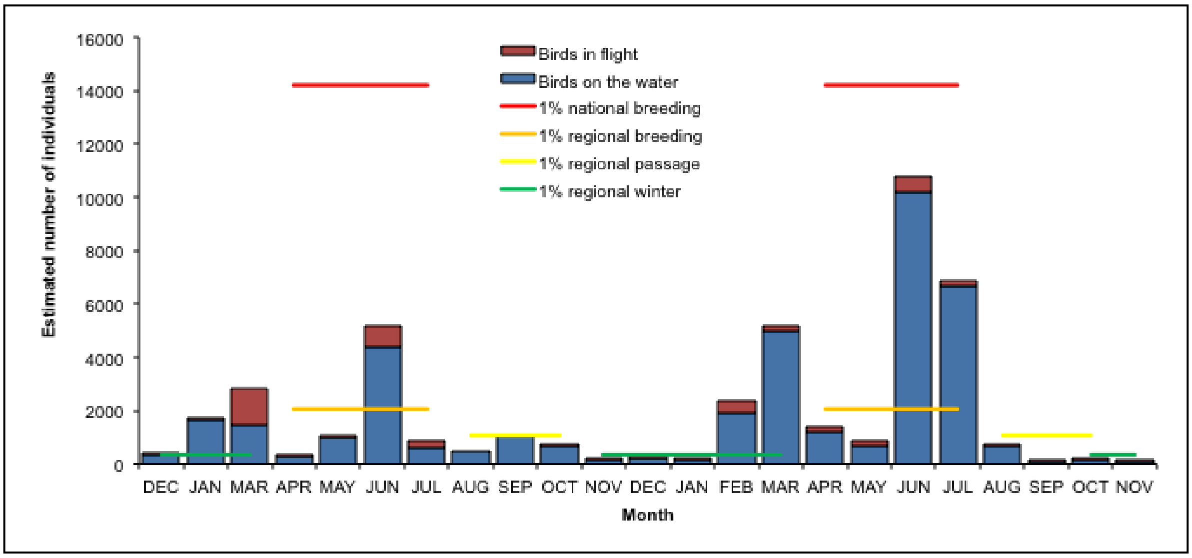
10.223. Peak numbers during any breeding season were achieved in June in both years at either site, with all exceeding the 1% regional criterion of 2,067 individuals. The passage threshold was not exceeded at either site during the study period, although the March estimates exceeded the winter regional thresholds (Plots 10.14 & 10.15). The monthly mean density incorporating DISTANCE analysis (individual models) of birds on the water for June (40.6 and 36.5 individuals/ km^2 for Project Alpha and Project Bravo respectively) were slightly lower than that previously reported in the wider area by Skov *et al.* (1995) at Wee Bankie at 59 individuals/ km^2. Higher density was expected within core foraging areas for Guillemots from the different areas (see Daunt *et al.*, 2011a,b,c).

Plot 10.13 Relative abundance of Guillemot expressed as density (individuals/km^2) of birds on the water derived from bands A and B in 1km^2 grid cells across Project Alpha and Project Bravo in the breeding season of April to July in 2010 (above) and 2011 (below).

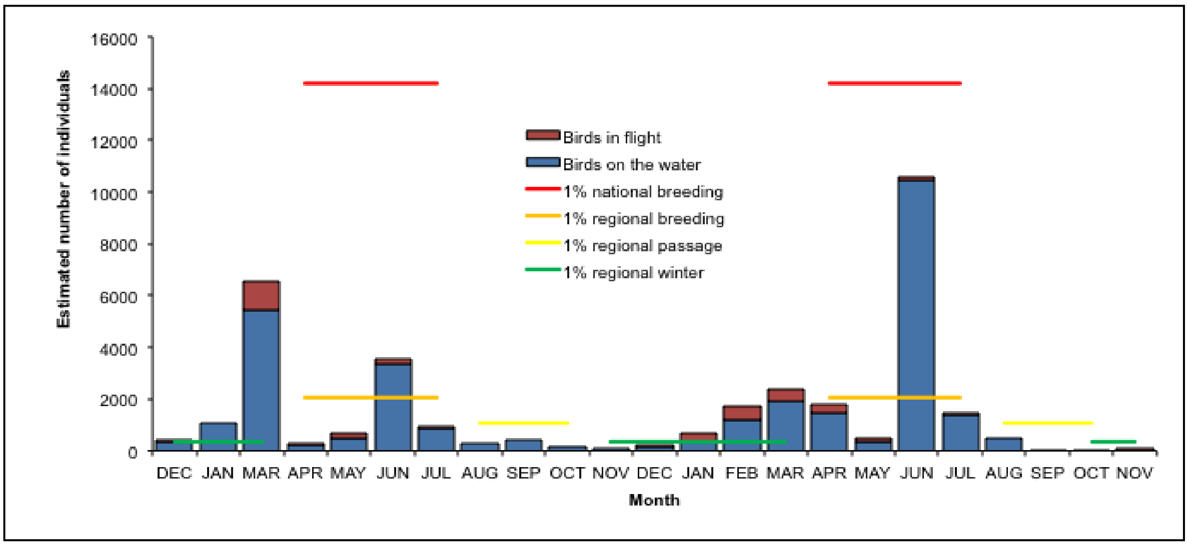




Plot 10.14 Guillemot population estimates by month derived from boat-based surveys of Project Alpha. Estimates are derived from DISTANCE corrected densities for birds on the water and snapshots for flying birds. The 1% criteria for nationally and regionally important populations are shown.



Plot 10.15 Guillemot population estimates by month derived from boat-based surveys of Project Bravo. Estimates are derived from DISTANCE corrected densities for birds on the water and snapshots for flying birds. The 1% criteria for nationally and regionally important populations are shown.



10.224. Guillemot was ranked 20th of 26 seabirds in the vulnerability index to offshore wind farms by Garthe & Hüppop (2004). Separating the main risks of collision with turbines and displacement, Furness & Wade (2012) ranked the auk as 21st and 11th respectively amongst the 37 seabirds considered. The potential for significant ecological impact through collision is very low, predominantly due to a lack of flight activity and low flight height. The modelled proportion >20m flight height by Cook *et al.* (2011) was just 4.1%, with data from boat-based surveys of Project Alpha and Project Bravo establishing even lower proportions of 1% or less. As such, CRM was not conducted on Guillemot for this EIA

10.225. Given the high densities present within both Project Alpha and Project Bravo during the breeding season, there was however potential for significant ecological impact through displacement. Whilst direct feeding behaviour was limited in both sites, the observations of birds carrying fish in the direction of Fowlsheugh especially within Project Alpha indicates foraging does occur. This also carries an implication of a potential barrier effect as McDonald *et al.* (2012) have recently concluded that displacement and barrier effects could affect time/energy budgets with consequences for breeding performance and/or survival after modelling potential effects on the Guillemot population of the Isle of May in the presence of Neart na Gaoithe.

10.226. Although Guillemot may be more adaptable than other auks, as a result of greater niche breadth and reduced dependence on particular prey fish, there is still potential for the footprint from the development sites to extend far beyond site boundaries, perhaps into core foraging areas for birds from several colonies. As such, indirect effects, through construction impacting on prey, are also considered for impact assessment within this ES chapter.

Razorbill

10.227. Razorbill is far less numerous than Guillemot, with a world population of 610,000 to 630,000 pairs (Mitchell *et al.*, 2004), with 75% of its global range within Europe, where it is Secure (BirdLife International, 2004). The UK supports 20.2% of the *islandica* race, with 187,100 breeding individuals (JNCC, 2011) and is of Amber conservation concern as a result of 50% of the population located at ten or fewer sites (Eaton *et al.*, 2009).

10.228. Breeding failure has been noted at many colonies in recent years coincident with food shortages which appears to be linked in a complex way to climate change and rising sea surface temperatures and decreasing productivity of sandeels (Frederiksen *et al.*, 2004), one of the small shoaling species upon which Razorbill is thought to depend (Wanless *et al.*, 1998).

10.229. As with Guillemot, Razorbill was recorded in all surveys of Project Alpha and Project Bravo during the study period. A similar pattern was recorded in both sites, in that numbers were relatively high before and at the start of the breeding season, followed by a decline during the incubation/chick provisioning periods in May and June, before increasing again at the end of the breeding season and during initial post-breeding dispersal (Plots 10.16 & 10.17). During the breeding season, the proportion of adults was relatively low at 58% for Project Alpha and 64% although the proportion aged was rather low at n = 148 and n = 66 respectively.

10.230. All surveys of Project Alpha and Project Bravo in the breeding season and during the passage period recorded regionally important numbers (Plots 10.16 & 10.17), with the peak July 2011 population in Project Alpha (2,120 individuals derived from an individual DISTANCE model) surpassing the national 1% threshold of 1,886 individuals, the highest population in that year (Plot 10.16). In 2010, the peak population estimate was 1,535 individuals in August during dispersal. In Project Bravo, the peak population estimates (all derived from global DISTANCE models) were consistently recorded later during autumn dispersal in September with populations of 1,293 birds in 2010 and 994 birds in 2011 (Plot 10.17).

10.231. The mean density per month was generally higher in Project Alpha than Project Bravo, with densities in the peak months comparable to those presented by Skov *et al.* (1995) for the key areas of Moray Firth (6.1 ind./km^2) and Scalp Bank (7.1 ind./km^2), an area adjacent to Project Alpha.

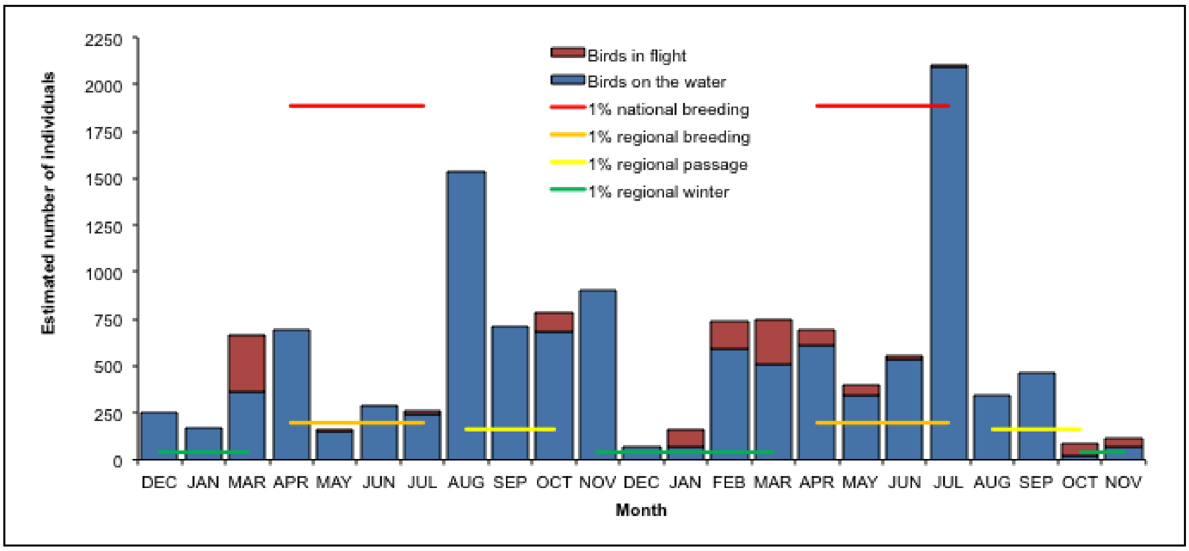
10.232. The distribution of Razorbill within both Project Alpha and Project Bravo was patchy, with large areas where no birds were recorded (Plot 10.18). There was also considerable inter-annual variation in density distribution, with the northwest of Project Alpha extending into Project Bravo supporting more birds in 2010, whereas in 2011 birds were clustered along the eastern edge of Project Alpha near to Scalp Bank.

10.233. Foraging range from colonies helps explain the distribution of Razorbill. Based on the mean maximum foraging range of 48.5km, only colonies to northwest of the sites are within range, with the largest, Fowlsheugh SPA supporting 4,632 individuals in 2009.

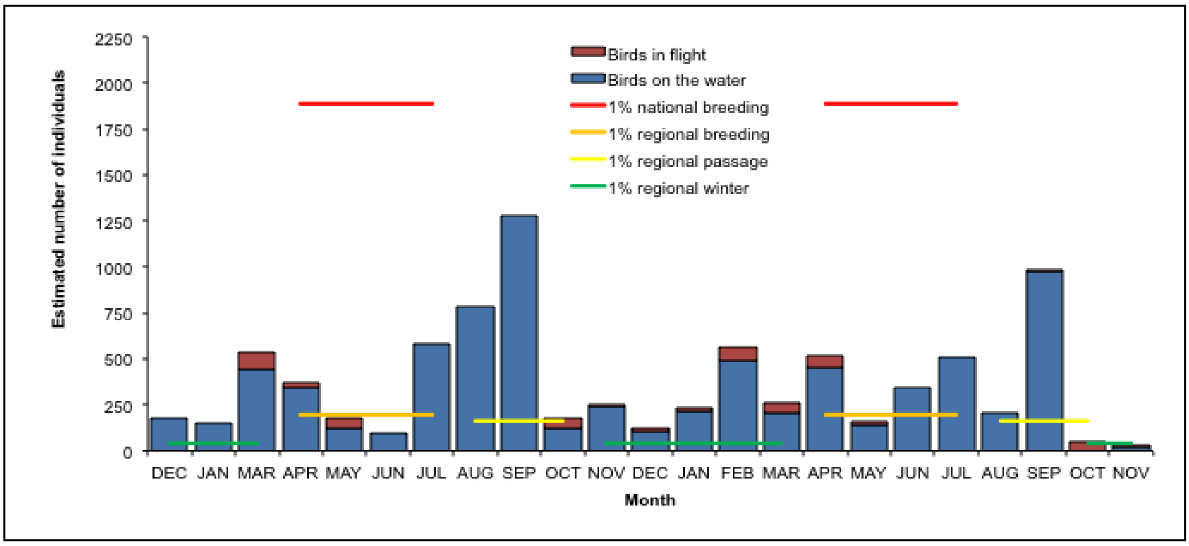
Fowlsheugh was the eighth largest colony of Razorbill in Britain and Ireland in the national census of Seabird 2000 (Mitchell *et al.*, 2004).

10.234. Although the Forth Islands SPA supporting 734 individuals in 2011, falls within foraging range with one standard deviation (83.5km), tracking studies from the Isle of May in 2010 showed that no birds reached Project Bravo, whilst only 2% of trips reached Project Alpha, although this fell outside core foraging habitat (Daunt *et al.*, 2011a). The suggestion that the majority of Razorbills present within both Project Alpha and Project Bravo during the breeding season originate from Fowlsheugh was supported by a predominant north or northwesterly flight path (64% of records in both Project Alpha and Project Bravo).

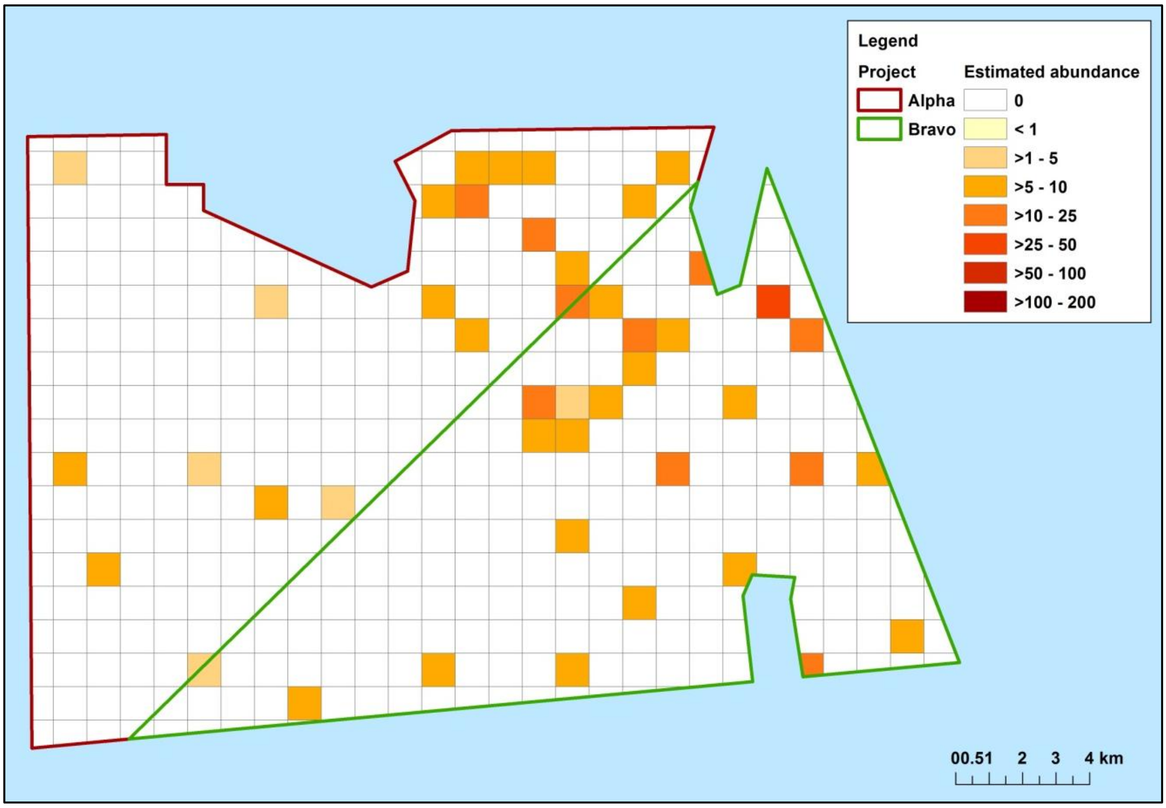
Plot 10.16 Razorbill population estimates by month derived from boat-based surveys of Project Alpha. Estimates are derived from DISTANCE corrected densities for birds on the water and snapshots for flying birds. The 1% criteria for nationally and regionally important populations are shown.

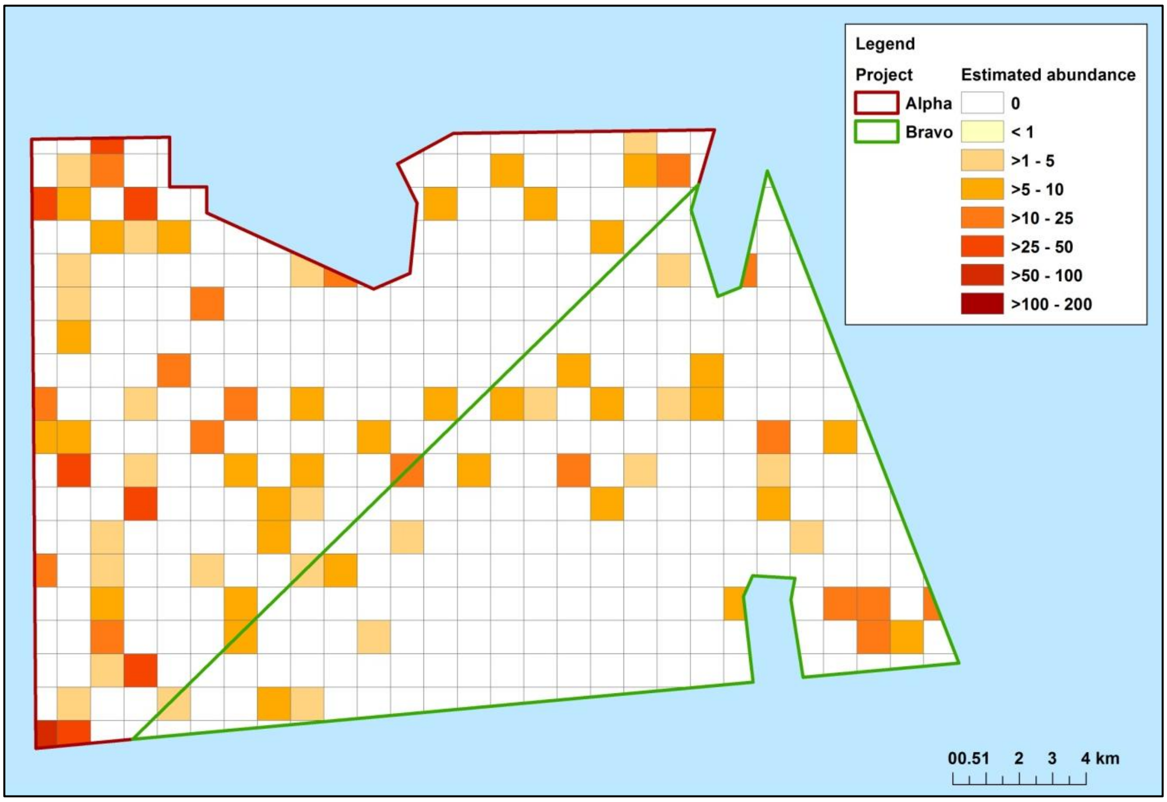


Plot 10.17 Razorbill population estimates by month derived from boat-based surveys of Project Bravo. Estimates are derived from DISTANCE corrected densities for birds on the water and snapshots for flying birds. The 1% criteria for nationally and regionally important populations are shown.



Plot 10.18 Relative abundance of Razorbill expressed as density (individuals/km^2) of birds on the water derived from bands A and B in 1km^2 grid cells across Project Alpha and Project Bravo in the breeding season of April to July in 2010 (above) and 2011 (below).





10.235. Garthe & Hüppop (2004) considered Razorbill to be slightly more susceptible to offshore wind farms than Guillemot (as a result of higher conservation and threat status and smaller biogeographical population size) with a ranking of 13th of 26 species. Furness & Wade (2012) considered the species' similar in their vulnerability, ranked 19th in regard to collision and 12th for displacement. The data gathered from boat-based surveys showed that Razorbill spent a relatively low proportion of time in flight (22% and 16% in Project Alpha and Project Bravo respectively), but with no birds at >20m within Project Bravo and only 1% in Project Alpha. These proportions were lower than that modelled by Cook *et al.* *(*2011) at 6.8%. Overall, the potential for significant ecological impact upon Razorbill as a result of collision risk was extremely low and this was not considered further.

10.236. As the bulk of the Razorbill were observed sitting on the water, coupled with 9% and 18% of all birds observed in feeding activity, albeit outside the breeding season, displacement is carried forward for further analysis within this ES chapter. The concentration of feeding records towards the southwestern corner of both Project Alpha and Project Bravo was suggestive of a link with Scalp Bank. As this lies adjacent to Project Alpha at least, the potential for indirect effects of construction on prey depended on the size of the footprint of construction noise, requiring further consideration in this ES. The links to the SPA colonies especially at Fowlsheugh suggested that barrier effects also needed to be considered in greater depth.

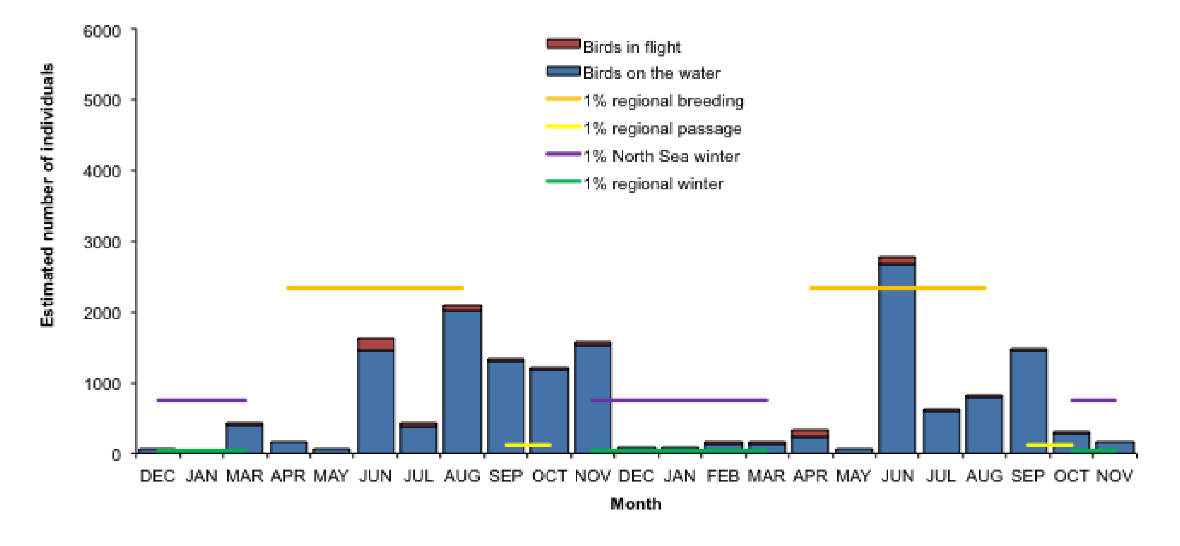
Atlantic Puffin

10.237. Although around 94% of the very large global population of 5.5 to 6.6 million breeding pairs of Puffin (Mitchell *et al.*, 2004), is concentrated in Europe, the species is classed as Depleted (BirdLife International, 2004). In the UK there are 580,700 breeding pairs, 10% of the world population (JNCC 2011). Approximately 85% of the UK population breed in Scotland, with the Isle of May, part of the Forth Islands SPA, being one of the largest UK colonies (124,398 individuals in 2010). Localisation within a few large colonies confers Amber conservation concern in the UK (Eaton *et al.*, 2009).

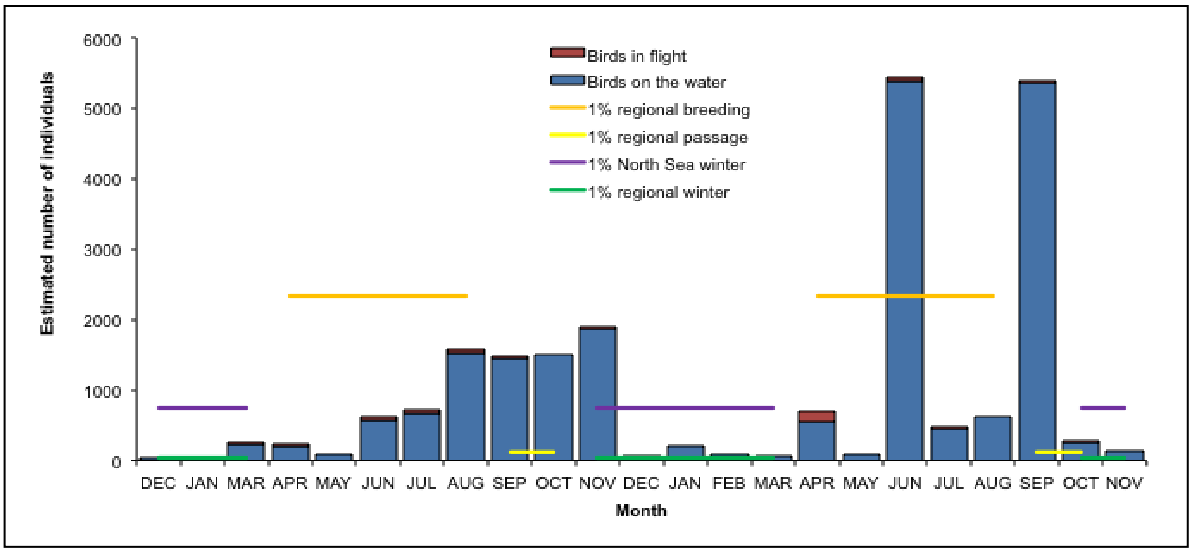
10.238. The seasonal pattern observed in Project Alpha and Project Bravo differed from the other two breeding auks. Numbers remained low up to, and including the start of the breeding season, but increased in June, during chick provisioning. The peak population estimates for Project Alpha and Project Bravo were recorded in the June 2011 survey with estimates of 2,666 and 5,583 birds respectively (using individual DISTANCE models). These were the only estimates to exceed the regional breeding population threshold of 2,328 Puffin (Plots 10.19 & 10.20). During the breeding season, adults comprised 72% of the aged sample in Project Alpha (*n* = 114) and 64% of the sample in Project Bravo (*n* = 113)

10.239. In 2010, high numbers were maintained throughout the passage period whereafter they decreased dramatically and remained low. All surveys during the passage period provided estimates that exceeded the 1% threshold (115 individuals) and where numbers were maintained into the November survey in 2010, the 1% threshold for the wider North Sea (746 individuals), representing at least national importance was exceeded in both sites (Plots 10.19 & 10.20). In 2011, numbers decreased in July and August, increased in September during the passage period and decreased again before the onset of winter (Plots 10.19 & 10.20).

Plot 10.19 Puffin population estimates by month derived from boat-based surveys of Project Alpha. Estimates are derived from DISTANCE corrected densities for birds on the water and snapshots for flying birds. The 1% criteria for North Sea and regionally important populations are shown.



Plot 10.20 Puffin population estimates by month derived from boat-based surveys of Project Bravo. Estimates are derived from DISTANCE corrected densities for birds on the water and snapshots for flying birds. The 1% criteria for North Sea and regionally important populations are shown.



10.240. Estimated density values incorporating DISTANCE-correction for birds on the water for both sites were broadly similar for both Project Alpha and Project Bravo on a mean monthly basis and were generally lower than those of Skov *et al. (*1995) for the Isle of May at 16.3 individuals/ km^2, although this was matched for Project Bravo in June. The peak density of >17 individuals/ km^2 in September in Project Bravo (cf. 7 individuals/ km^2 in Project Alpha) appears to be more exceptional although data are scant and this simply requires equivalent values for the breeding season to be maintained into the dispersal period.

10.241. Puffin was generally evenly distributed throughout both Project Alpha and Project Bravo although with a tendency to occur in patches of > 25 individuals/ km^2 interspersed by lower values. There was no clear preference for specific areas although there was some evidence that the northwest corner of Project Alpha was not utilised by Puffin in 2011, particularly during the breeding season.

10.242. Whilst there are some small colonies to the west and northwest, including Fowlsheugh (30 individuals in 2006), it seems likely that most birds recorded during the breeding season originate from the large colony on the Isle of May in the Forth Islands SPA, as also reinforced by the northeast to southwest flight axis corresponding to a flight path from and to the Isle of May. Limited tracking studies of Puffin from the Isle of May confirmed that birds could reach the Projects, with one of the seven birds from which data were retrieved just reaching Project Alpha but not Project Bravo.

10.243. Projects Alpha and Bravo also fall within the mean maximum foraging range (105km – Thaxter *et al.*, 2012) of the Farne Islands in Northumberland (73,670 individuals in 2008) although recent tracking suggests that foraging is concentrated within about 30km of the colony (http://www.bbc.co.uk/news/10528822), and thus it is very unlikely that birds from the Farnes will reach Projects in the breeding season or even spend much time at all in the wider Firth of Forth.

10.244. In their vulnerability index to offshore wind farms for seabirds, Garthe & Hüppop (2004) ranked Puffin 14th of 26 seabirds. Dividing the main risks of collision and displacement, Furness & Wade (2012) ranked Puffin 35th from 37 seabirds in terms of collision risk and 17th in terms of potential displacement, the lowest ranks in both categories for the breeding auks.

10.245. As with Guillemot and Razorbill, the numbers of birds recorded in flight and the very low proportion of flights observed at risk height (0.5% and 0% in Project Alpha and Project Bravo respectively, meant that there was extremely limited potential for significant ecological impact of collision and this was not considered in this ES.

10.246. Although Puffins are considered less sensitive to disturbance that the other auk species, the relatively high numbers of birds recorded at the time of chick provisioning and the links to the Forth Islands SPA meant that displacement, including barrier effects were considered for both Projects in this ES.

10.247. Indirect effects were also considered, as although sandeels (especially 0-group) dominate the provisions to chicks, clupeids may be important in some years, especially by biomass (Harris & Wanless, 2011). Clupeids are known to be highly sensitive to the effects of construction noise (Thomsen *et al.*, 2006).

European Herring Gull

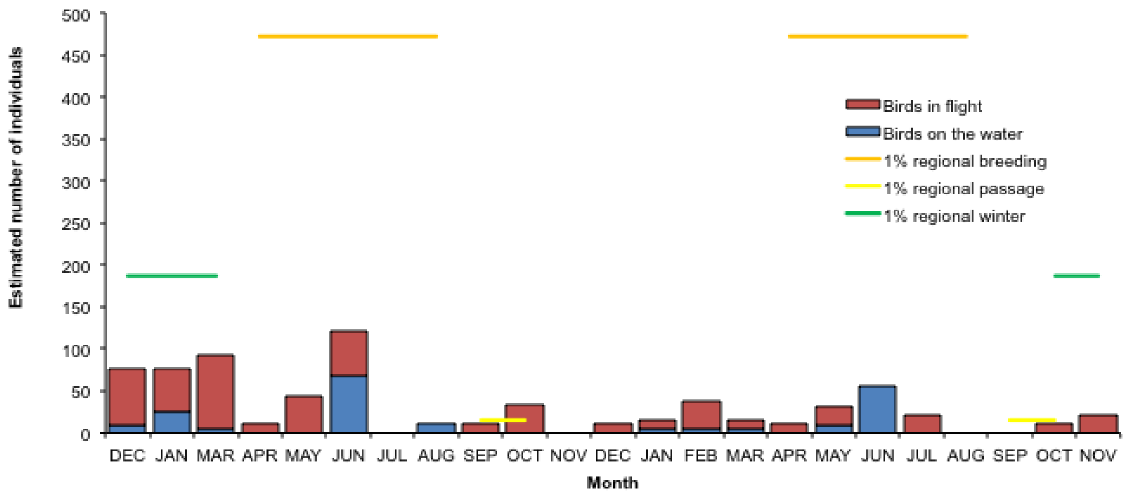
10.248. The European population of Herring Gull is classed as Secure with an estimated 760,000 to 1,400,000 breeding pairs (BirdLife International, 2004). In contrast, the UK population of the *argenteus* race (139,200 pairs) is of Red conservation concern (Eaton *et al.*, 2009), following a continued dramatic decrease in the breeding population since 1969 (Mitchell *et al.*, 2004, JNCC, 2011). Herring Gull is now also a priority UK BAP species.

10.249. The Forth Islands SPA comprising the Isle of May, Craigleith, Eyebroughty, Fidra, Inchmickery, Bass Rock and The Lamb combined was the third largest 'colony' in Britain and Ireland in Seabird 2000 with 4,814 pairs (Mitchell *et al.*, 2004). Further colonies in the Forth include Inchkeith (3,580 pairs) and Inchcolm (621 pairs).

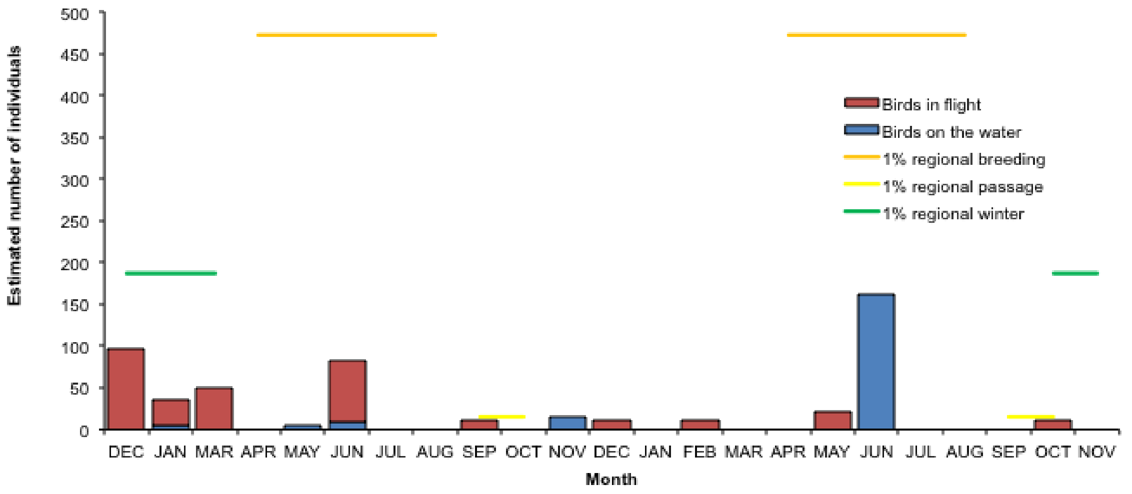
10.250. Herring Gull was recorded in all but three surveys of Project Alpha, but was absent in seven surveys of Project Bravo. Regionally important numbers were not recorded in either site during the breeding season or winter periods. The peak breeding season estimates of 121 birds in Alpha (June 2010) and 163 individuals in Bravo (June 2011) were well below the 1% threshold of 472 individuals (Plots 10.21 & 10.22).

10.251. Monthly mean densities for Project Alpha ranged from 0.05 to 0.45 individuals/ km^2, with those in Project Bravo ranging from 0 (April, July and August) to 0.63 individuals/ km^2. Values were considerably lower than those of the literature for the western North Sea (Stone *et al.*, 1995) and areas including the Firth of Forth (Skov *et al.*, 1995). With the generally low numbers, no clear pattern of distribution was established in either site.

Plot 10.21 Herring Gull population estimates by month derived from boat-based surveys of Project Alpha. Estimates are derived from standard techniques using line transects and snapshots for flying birds. The 1% criteria for regionally important populations are shown.



Plot 10.22 Herring Gull population estimates by month derived from boat-based surveys of Project Alpha. Estimates are derived from standard techniques using line transects and snapshots for flying birds. The 1% criteria for regionally important populations are shown.



10.252. The pooled aged sample of birds during the breeding season was relatively small at *n* = 51, but this would seem to be sufficient to broadly describe the proportion of adults occurring in the two sites. Adults comprised 69% of individuals aged although the breeding status of apparent adults cannot be unequivocally established and some may be even be non-breeders. Whatever the case, relatively few adults from the breeding colonies seem likely to reach Project Alpha and Project Bravo.

10.253. Two SPAs, Fowlsheugh and the Forth Islands fall within foraging range of Project Alpha and Project Bravo in the breeding season (61.1km – Thaxter *et al.*, 2012). Although closer at 30km the relatively small number of breeding birds present (428 individuals in 2009) may mean that birds from the much larger colonies in the Forth Islands SPA (6,442 individuals in 2010 make a greater contribution. However, there are 53 colonies within the mean maximum foraging range that may contribute to the birds present in Project Alpha and Project Bravo.

10.254. The dominant flight direction of northeast recorded at Project Alpha with no reciprocal dominant southwest flight path does suggest that any adult birds present in the breeding season are likely to originate from the Forth Islands. Information from Project Bravo was slightly conflicting with both northeast (perhaps from the Forth Islands) and northwest (perhaps returning to Fowlsheugh or the other colonies along the Aberdeenshire coastline) directions of flight represented.

10.255. Low numbers of potentially breeding adults Herring Gulls and low susceptibility to any form of displacement (see Petersen *et al.*, 2006, Krijgsveld *et al.*, 2011) meant that there was no likelihood of significant ecological impact of displacement, including barrier effects or indirect effects and thus not considered within this ES chapter.

10.256. Despite the high vulnerability of Herring Gull to collision (ranked 2nd of 37 seabirds by Furness & Wade, 2012), the potential for a significant ecological impact of each Project in isolation was considered to be low as a result of the involvement of relatively few adult birds. However, the potential for cumulative impact between the Projects could not be entirely discounted and thus collision risk modelling was undertaken in this ES as a precautionary measure, especially as Marine Scotland had requested the inclusion of Herring Gull as a sensitive receptor in an initial scoping of effects of the wind farms in the Firth of Forth (NIRAS Consulting Ltd, 2012).

Great Black-backed Gull

10.257. Great Black-backed Gull has a global population of 540,000-750,000 mature individuals and a European population of 110,000 to 180,000 breeding pairs, generating a Secure conservation status in both a global and European context (BirdLife International, 2004). In the UK, the species is a relatively uncommon breeding seabird with approximately 16,800 pairs (Eaton *et al.*, 2011, Mitchell *et al.*, 2004). Although of Amber conservation concern in the UK, it is a moderate decline in the non-breeding population that is the cause of concern (Eaton *et al.*, 2009).

10.258. Peak numbers of Great Black-backed Gulls were achieved during the passage period in both years. In October 2010, estimates of 257 and 245 individuals in Project Alpha and Project Bravo respectively exceeded the 1% threshold of 101 Great Black-backed Gull at this time (Plots 10.23 & 10.24). In 2011, the peak in passage birds was recorded in September, but did not reach the 1% criterion of regional importance in either site.

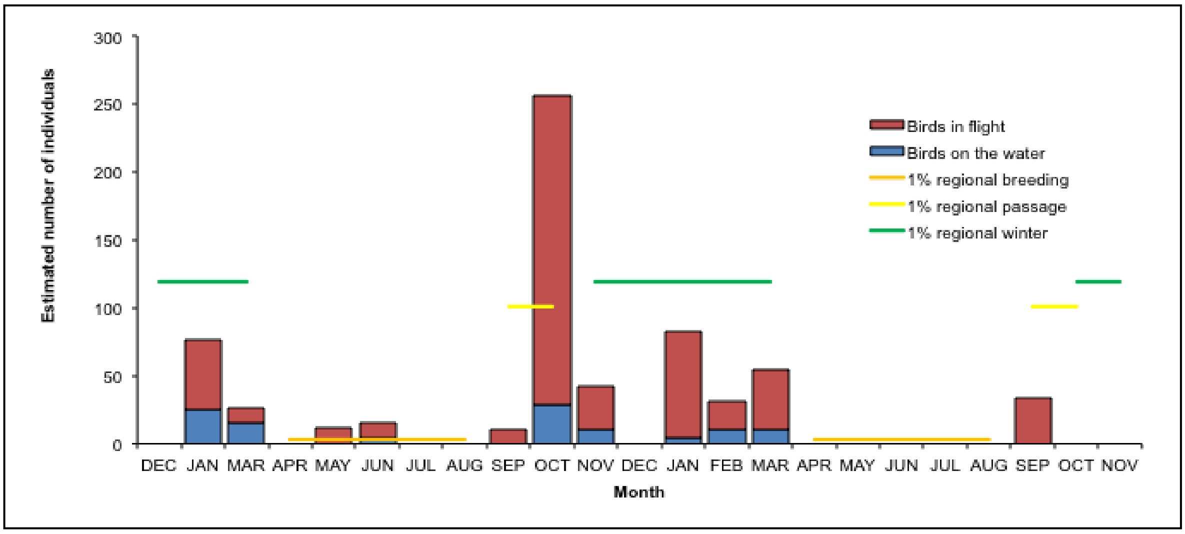
10.259. During the winter months there is an influx of Great Black-backed Gulls to the UK, especially from Norway. Up to 2,000 are recorded on the Isle of May in the Firth of Forth in most winters, peaking in November and December (Forrester *et al.*, 2007). Whilst birds were present on both sites throughout the winter months, these only exceeded the criterion for regional importance in winter on one occasion in Project Bravo. The mean densities per month that were comparable within both Alpha and Bravo, ranged from 0 to 0.7 ind./ km^2 in the passage and winter period, which were generally lower than those presented by Skov *et al.* (1995) for the wider Firth of Forth region (1.1 ind./ km^2).

10.260. There are 32 colonies of Great Black-backed Gull within foraging range of ~100km from Project Alpha and Project Bravo. These contain only 288 breeding birds which means the 1% regional population criterion for the breeding season is very small. Great Black-backed Gull occurred sporadically in the breeding season in both Projects, but when it did the numbers involved invariably exceeded the low population criterion (Plots 10.23 & 10.24). However, the small aged sample (n = 20) of birds during the breeding season suggested 55% of birds were adult, which in turn, were assumed to be breeding birds.

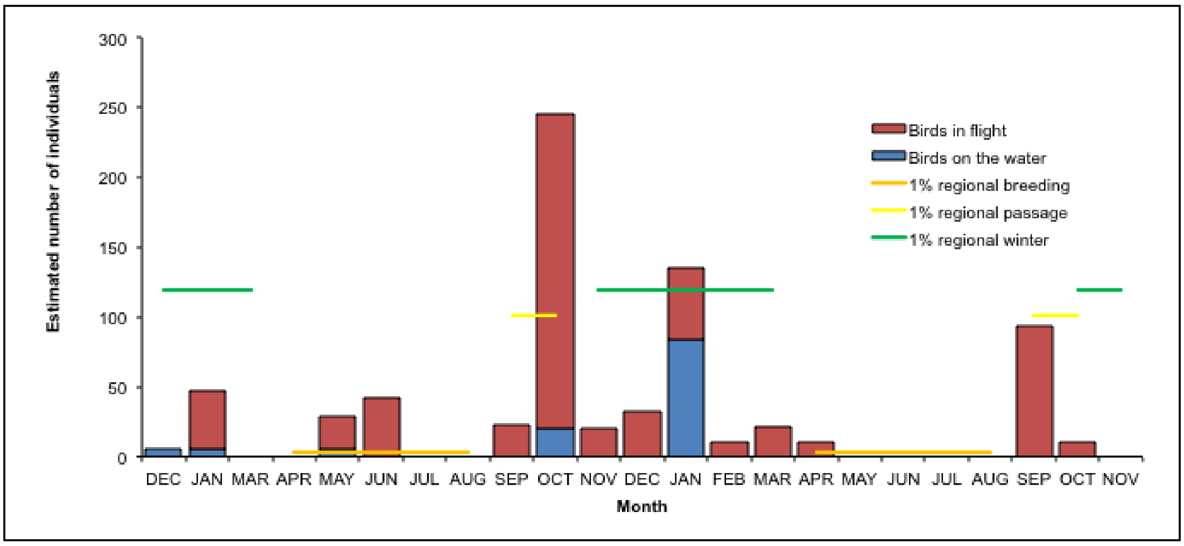
10.261. The origin of these breeding birds is difficult to determine but there is some chance that birds from three SSSIs for the species, comprised of the Forth Islands SSSI (Craigleith, Fidra and the Lamb), Bass Rock SSSI and Fowlsheugh SSSI are involved. The flight direction of the small numbers of birds in the breeding season provides little insight on the potential origin of birds and it could only be assumed that some birds from the largest colony on Craigleith (46 individuals) may be involved.

10.262. Scottish Great Black-backed Gulls are largely sedentary (Wernham *et al.*, 2002) and thus the birds recorded during the breeding season are likely to remain and form part of the wintering population, perhaps comprising as much as 10% of the minimum total of at least 2,000 birds (see 10.259 above). It is this occurrence of the same individuals that are exposed to risk throughout the year, that if impacted could affect SSSI breeding populations that was of most concern.

Plot 10.23 Great Black-backed Gull population estimates by month derived from boat-based surveys of Project Alpha. Estimates are derived from standard techniques using line transects and snapshots for flying birds. The 1% criteria for regionally important populations are shown.



Plot 10.24 Great Black-backed Gull population estimates by month derived from boat-based surveys of Project Bravo. Estimates are derived from standard techniques using line transects and snapshots for flying birds. The 1% criteria for regionally important populations are shown.



10.263. Garthe & Hüppop (2004) considered Great Black-backed Gull as the most vulnerable of the gull species to offshore wind farms with a rank of ninth, whereas Furness & Wade (2012) ranked the species as *the* most sensitive seabird to the impact of collision with turbines. The high risk of collision is a consequence of the study by Cook *et al. (*2011) that concluded that Great Black-backed Gull had the highest proportion of flights above 20m at 35.1%. Very similar proportions were recorded from boat-based surveys of the Project Alpha and Project Bravo with 32% and 34% respectively. As such, there was some prospect of a significant ecological impact on the population, particularly in a cumulative context, requiring assessment through collision risk analysis in this ES.

10.264. Whilst Furness & Wade (2012) consider Great Black-backed Gull as the most vulnerable gull to displacement (23rd), part of the sensitivity of the species to collision is due to the observations that they are often not displaced from wind farms during construction or whilst in operation partly (see Petersen *et al.*, 2006, Krijgsveld *et al.*, 2011). As a scavenger Great Black-backed Gull may attend vessels and collect any collision victims and as a predator may benefit in the short term if fish are injured as a result of construction. No further assessment of displacement, barrier effects or indirect effects was deemed to be required.

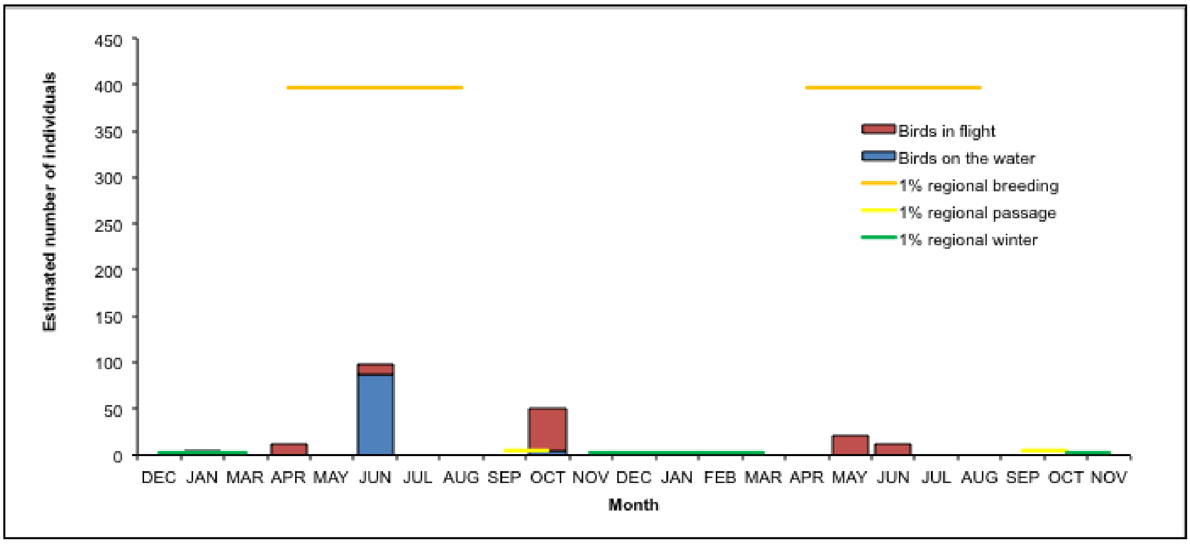
Lesser Black-backed Gull

10.265. The European population of 300,000 to 350,000 breeding pairs of Lesser Black-backed Gull has a Secure conservation status (BirdLife International, 2004). Three races are present in Western Europe with the *graellsi* race comprising the breeding birds of Britain and Ireland (Parkin & Knox 2010). Mitchell *et al. (*2004) recorded 112,000 breeding pairs in the UK, equating to 63% of the global *graellsi* population, which is of international importance thereby conferring Amber conservation status in the UK (Eaton *et al.*, 2009). Localisation of the breeding population in <10 sites also contributes to this status. In terms of population size, numbers of breeding pairs have fluctuated since the 1990s.

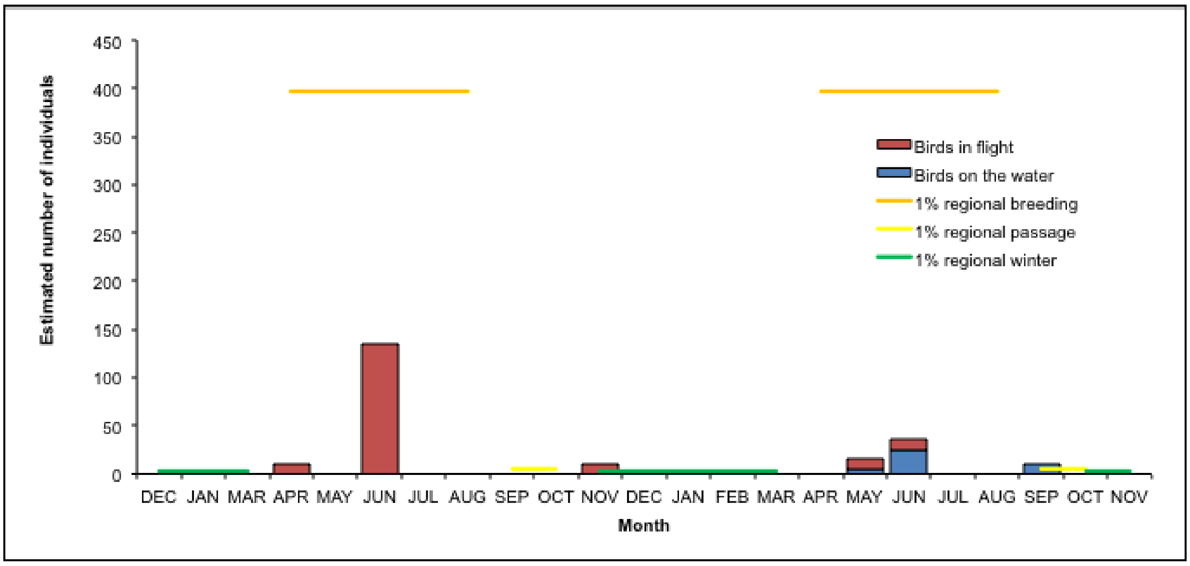
10.266. Lesser Black-backed Gull was present in the early stages of the breeding season, between April and June, although regionally important numbers were not recorded in either Project Alpha or Project Bravo (Plots 10.25 & 10.26). The densities for April and June at <0.1 individuals/ km^2 were comparable to the general densities for the western North Sea (Stone *et al.*, 1995), with the mean density in June similar to that previously reported for the Firth of Forth to Farn Deeps (0.1 ind./ km^2) by Skov *et al.* (1995). However, important areas of the North Sea support densities between 4-14 individuals/ km^2 at this time (Skov *et al.*, 1995).

10.267. Regionally important numbers were however attained during the passage period at Project Alpha in October 2010 and September 2011 at Project Bravo, although the 1% criterion is very low (five individuals). The occurrence of birds on passage is consistent with the migration of Lesser Black-backed Gulls from breeding areas. Wintering birds have become increasingly common in Scotland and although these can be observed on the coast, aggregation typically occurs at inland reservoirs (Forrester *et al.*, 2007). The lack of birds at Project Alpha and Project Bravo during the winter months is thus consistent with the location of the sites at some distance from shore.

Plot 10.25 Lesser Black-backed Gull population estimates by month derived from boat-based surveys of Project Alpha. Estimates are derived from standard techniques using line transects and snapshots for flying birds. The 1% criteria for regionally important populations are shown.



Plot 10.26 Lesser Black-backed Gull population estimates by month derived from boat-based surveys of Project Bravo. Estimates are derived from standard techniques using line transects and snapshots for flying birds. The 1% criteria for regionally important populations are shown.



10.268. The peak numbers were recorded in June 2010, with an estimated 98 Lesser Black-backed Gulls in Project Alpha and 135 in Project Bravo. During the breeding season, the majority of birds aged were adults (90% at Project Alpha and 69% at Project Bravo) albeit from a small aged sample (*n* = 34). Thus the occurrence of birds on the sites is suggestive of breeding birds foraging to provision chicks, although no exhibiting direct feeding behaviours at either development site.

10.269. Breeding birds could originate from 53 colonies based on a mean maximum foraging range of 141km (Thaxter *et al.*, 2012). A single SPA, the Forth Islands, and a single SSSI at Fowlsheugh fall within foraging range. Whilst the latter colony is very small with only a single pair in 2010, the number of birds in the Forth Islands SPA is large with 6,914 individuals, equating to 39% of the total number within mean maximum foraging range. The Forth Islands SPA is however ~72km away from Project Alpha and Project Bravo and a review of Lesser Black-backed Gull foraging behaviour by Galloper Offshore Wind (2011) showed that core foraging range is within 40km of the colony. Nonetheless, as the colonies in the cities of Aberdeen and Dundee, both within 65km, are relatively small (308 and 130 birds respectively) compared to the Forth Islands, it seems likely that birds from the Forth Islands will be represented.

10.270. Analysis of flight direction was hindered by small sample size, but did suggest some mixed origin of birds with westerly and northwesterly flights recorded in Project Alpha suggestive of return to the closest colonies. In contrast, a southeasterly flight direction was prominent at Project Bravo, indicative of a return to the Forth Islands.

10.271. The relative lack of Lesser Black-backed Gulls in either site, an absence of feeding activity and the general lack of evidence from constructed sites (e.g. Krijgsveld *et al.*, 2011), led to no further consideration of any form of displacement including barrier effects in the operational stage of the projects, or of indirect effects during the construction phase. However, the species is considered to be vulnerable to collision with turbines, being ranked third by Furness & Wade (2012), predominantly due to their flight altitude (Garthe & Hüppop 2004). Small sample size led to variation in the proportion of birds at >20m recorded in Project Alpha (62%) and Project Bravo (29%), with only the latter resembling the modelled proportion of 27% by Cook *et al. (*2011).

10.272. Despite relative vulnerability, the low numbers of Lesser Black-backed Gulls present meant that the potential for impact from collision with turbines at each site in isolation was very low. The species is however carried forward as a sensitive receptor in this ES chapter as the prospect of a significant ecological impact as a result of cumulative effects of the sites and with the STW developments could not be discounted. Moreover, consideration within EIA mirrored the need to consider Lesser Black-backed Gulls as part of the HRA process as a result of the potential link to the Forth Islands SPA.

Arctic Tern

10.273. The European population of Arctic Tern in excess of 500,000 pairs is classed as Secure (BirdLife International, 2004). Arctic Tern is the commonest breeding tern in the UK with 53,400 pairs, the majority of which (84%) breed in Scotland, especially on Shetland and Orkney (Forrester *et al.*, 2007). Listed under Annex 1 of the EC Birds Directive requiring the designation of SPAs, Arctic Tern is also of Amber conservation concern in the UK on account of a moderate long-term decline in the breeding range (Eaton *et al.*, 2009).

10.274. There was some variation in the patterns of occurrence of Arctic Tern at Project Alpha and Project Bravo (Plots 10.27 & 10.28), with birds present in low numbers throughout the summer in 2010 in Project Bravo, whereas Arctic Tern was only recorded in May 2011 possibly corresponding to a spring passage in Project Alpha. Project Alpha and Project

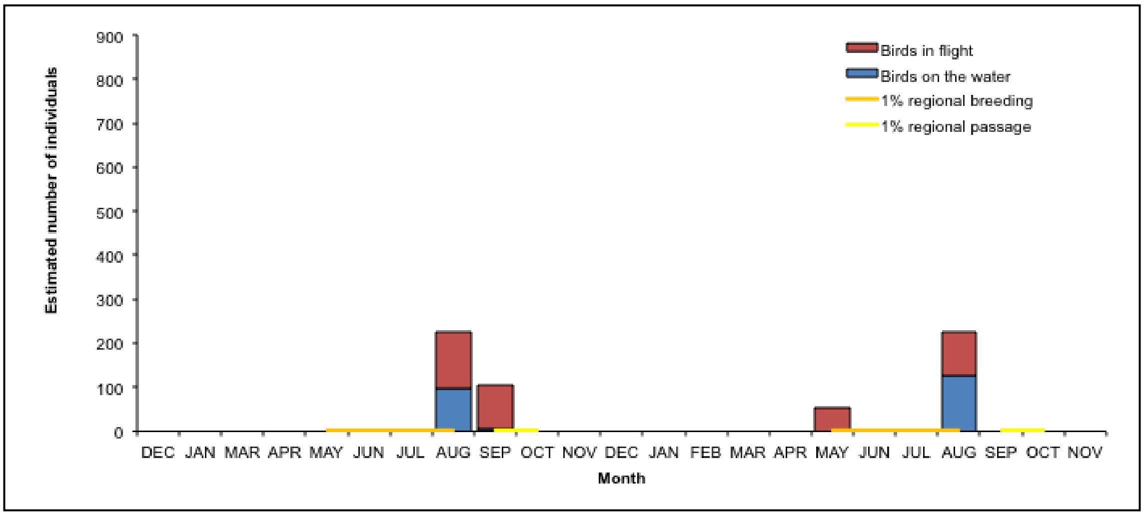
Bravo do fall within foraging range of three colonies (based on a mean maximum foraging range + 1SD of 30.5km – Thaxter *et al.*, 2012) although only 58 birds were present at these sites in relatively dated counts from 2000 to 2005. For birds present between May to July, late spring and early autumn passage to/ from Orkney and Shetland where a minimum of 70,000 individuals are known to breed (Forrester *et al.*, 2007) seems more likely to account for the birds present in what would otherwise be described as the breeding season.

10.275. In both sites and in both years, peak numbers of Arctic Tern were recorded during the autumn passage period (August and September), with peak estimates of 227 and 800 individuals within Project Alpha and Project Bravo respectively (Plots 10.27 & 10.28). The high estimate for Project Bravo in August 2010 of 4.1 individuals/ km^2 was a result of aggregations of foraging birds present within the site. Whilst such levels may be readily achieved in the vicinity of large colonies, there does not appear to record of such density on passage in offshore areas in the general literature.

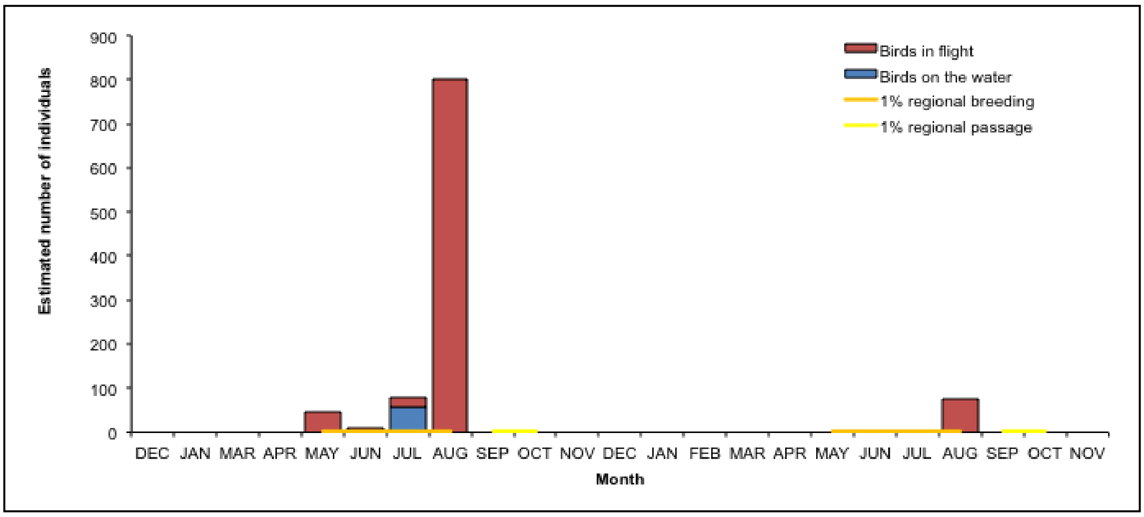
10.276. As described above (see 10.273) the majority of birds in autumn passage are likely to originate from Orkney and Shetland, some of which are known move southwards into the North Sea on autumn passage (Forrester *et al.*, 2007). More local birds included from the small population in the Forth Islands SPA may also be involved however. The Firth of Forth is known to be a key feeding area for passage Arctic Terns, which they may linger for 1-2 weeks before continuing their long southwards migration to Antarctica, approximately 20,000km from their breeding grounds, the longest and most extensive migration of any bird (Wernham *et al.*, 2002).

10.277. Garthe & Hüppop (2004) ranked Arctic Tern 17th from 26 species considered, whilst Furness & Wade (2012) providing the same rank in a larger dataset of 37 Scottish seabirds in relation to collision with turbines. Low flight altitude of the species was primarily responsible for relatively low ranking. Cook *et al.* (2011) modelled 4.4% of flights at >20 m, which was similar to that (5.1%) recorded from in the Project Bravo development site. No birds were in fact recorded flying above 20m in Project Alpha. A very low proportion at risk height coupled with restricted seasonal occurrence means there is a very low prospect of a significant ecological impact of collision, especially upon a very large passage population.

Plot 10.27 Arctic Tern population estimates by month derived from boat-based surveys of Project Alpha. Estimates are derived from standard techniques using line transects and snapshots for flying birds. The 1% criteria for regionally important populations are shown.



Plot 10.28 Arctic Tern population estimates by month derived from boat-based surveys of Project Bravo. Estimates are derived from standard densities using line transect and snapshot techniques. The 1% criteria for regionally important populations are shown.



10.278. Arctic Tern were ranked 16th by Furness & Wade (2012) in relation to displacement. There is little evidence for significant displacement of Arctic Tern (or the similar Common Tern) from wind farms (Christensen *et al.*, 2003, 2004). Indeed, there is a prospect of operational sites attracting Arctic Terns to exploit prey brought to the surface by currents around turbine bases (Linley *et al.*, 2007). As a passage species, there was no likelihood of a significant energetic effect of barrier effects (Masden *et al.*, 2009), even if displacement were to occur.

10.279. The evidence for the wider Firth of Forth as be an important stopover for Arctic Terns on migration (Forrester *et al.*, 2007), was supported by the observations of foraging behaviour in both Project Alpha and Project Bravo. As a result of the feeding aggregations recorded in August 2010, 57% of the overall count of Arctic Terns in Project Bravo exhibited feeding behaviour. Although the proportion was considerably smaller in Project Alpha (5%), most birds were recorded with no specific direction, indicative of foraging. Further consideration of the impact of indirect effects upon prey supply as a result of construction was therefore undertaken in this ES, even though this was limited by a lack of knowledge of the prey species taken at this time.

Transmission Asset Project

Infrastructure within the Project Alpha and Project Bravo site boundaries

10.280. Boat-based and aerial survey data for the assessment of Project Alpha and Project Bravo (see 10.177 to 10.182) were also used to inform the assessment of the existing environment as relevant to the Transmission Asset Project.

Export Cable Route (ECR) Corridor - offshore

10.281. Aerial survey data covering the offshore extent of the ECR included 17 species with a similar avifauna as recorded in Project Alpha and Project Bravo. Auk species occurred in the highest density. The largest flock of any one species observed was Manx shearwater.

Export Cable Route (ECR) Corridor – intertidal/nearshore

10.282. Through the tide vantage point surveys at the Carnoustie landfall site identified twenty five ‘primary target’ species, including:

- Bar-tailed Godwit: Annex I listed species;

- Great Northern Diver *Gavia immer* and Red-throated Diver *Gavia stellata*: Annex 1 and Schedule 1 listed species;
- Common Scoter *Melanitta nigra* and Long-tailed Duck *Clangula hyemalis*: Schedule 1 listed species;
- Eurasian Curlew (hereafter Curlew) *Numenius arquata* and Herring Gull: UK Biodiversity Action Plan (BAP) and Scottish Priority listed species;
- Black-headed Gull *Chroicocephalus ridibundus*: Scottish Priority listed species; and
- sixteen further Birds of Conservation Concern (BoCC) Amber listed species, and four species of lower conservation value.

10.283. In addition, two species that are included as qualifying features of the adjacent Firth of Tay and Eden Estuary SPA occurred: Bar-tailed Godwit and Redshank. Seven species that are listed in the SPA assemblage were noted: Long-tailed Duck, Cormorant, Eider, Common Scoter, Red-breasted Merganser *Mergus serrator*, Eurasian Oystercatcher (hereafter Oystercatcher) *Haematopus ostralegus* and Sanderling *Calidris alba*.

10.284. The most frequently recorded species was Eider, followed by Common Scoter and Herring Gull. Seabirds were widely recorded during the surveys with Razorbill, Guillemot, European Shag *Phalacrocorax aristotelis* and Gannet present throughout. Red-throated Diver was also seen in moderate numbers, while Great Northern Diver was recorded on a single occasion. Low numbers of waders were observed using the foreshore areas, with the most common species being Oystercatcher. Wildfowl were relatively numerous and were dominated by seaduck, including Eider, Long-tailed Duck, Common Scoter and Red-breasted Merganser.

ASSESSMENT OF IMPACTS – WORST CASE SCENARIO

10.285. The worst case scenario for each potential impact assessed with respect to the ornithological interest for Project Alpha and Project Bravo is outlined in Table 10.23, with the worst case for the Transmission Asset detailed in Table 10.24. The scenarios are derived from the Rochdale envelope, with full details of the developments provided in Chapter 5: Project Description.

IMPACT ASSESSMENT – CONSTRUCTION STAGE

Project Alpha

Displacement through disturbance due to increased boat traffic

10.286. The principal focus of displacement in the construction stage is through the disturbance of birds as a result of increased boat traffic. The increased traffic within the area, from construction vessels and service vessels transporting technicians and staff, remains throughout the construction stage. The impact can be frequent, but is considered short-term over the full timescale of Project Alpha.

10.287. All nine sensitive receptors have been considered for this potential impact. As described in Table 10.7, most sensitive receptors were considered to have high sensitivity score as a result of potential linkage with one or more SPAs (shown in Table 10.21). The exceptions were Great Black-backed Gull and Arctic Tern, which were both classed as of medium sensitivity.

Table 10.23 Worst case scenario assessed for Project Alpha and Project Bravo in regard to ornithology.

Effect	Worst case scenario	Justification
Construction		
Displacement through disturbance due to increased boat traffic	A maximum of eight service vessels will undertake an average of 1,760 trips per annum during the construction of Project Alpha. The number of vessels and trips has been considered for Project Bravo also.	These scenarios result in the maximum increase in boat traffic.
Indirect effects of construction on prey	Piled jackets, with four piles per jacket for 75 WTFs, three Meteorological Masts and three OSPs, using percussive impact piling. Eight hours required per pile, with three hours actual driving time. Additional hours will be required for some hard soils, potentially up to four hours. This scenario has been considered for both Project Alpha and Project Bravo	These scenarios are the maximum level of noise and duration which could impact on fish per site.
Operation		
Displacement	Areas of 197.2km² for Project Alpha and 193.7km² for Project Bravo, with 75 WTGs occupying the full extent of each site have been considered.	These scenarios lead to the greatest potential for displacement as they occupy the greatest area with the largest number of WTGs.
Barrier effects	See Displacement above for extent of footprints of both Project Alpha and Project Bravo.	These scenarios lead to the greatest potential barrier to the movement of birds.
Mortality through collision with turbine blades	Installation of 75 x 7 MW WTGs at both Project Alpha and Project Bravo. However, rotation speeds from 6 MW 126m rotor diameter WTGs used in modelling as this provides the worst case under the principle of the Rochdale Envelope.	These scenarios lead to the highest predicted collision rates given that the maximum number of WTGs has been fixed at 75 for Project Alpha and 75 for Project Bravo.
Decommissioning		
Displacement through disturbance due to increased boat traffic	As Construction above	As Construction above
Indirect effects of decommissioning on prey	Removal of all structures and cabling.	As Construction above

Table 10.24 Worst case scenario assessed for the Transmission Asset Project with regard to ornithology.

Project component		Dimensions	Legs per platform	Piles per leg	Piles per platform	Total piles	Gravity base footprint	Jacket footprint
OSP	HVAC collection platform x 4	40m x 40m x 45m (L/W/H)	6	2	12	48	1,600m²	20m²
	HVDC converter platform x 1	100m x 75m x 60m (L/W/H)	12	2	24	24	6,500m²	40m²
Maximum ECR corridor width		1km – 4.5km	n/a	n/a	n/a	n/a	n/a	n/a
Maximum no. OSP to OSP cable trenches		10	n/a	n/a	n/a	n/a	n/a	n/a
Maximum cable trench depth		3m	n/a	n/a	n/a	n/a	n/a	n/a
Maximum cable burial depth		3m	n/a	n/a	n/a	n/a	n/a	n/a
Maximum ECR length from Project Alpha OSP to MHWS at Carnoustie		70km	n/a	n/a	n/a	n/a	n/a	n/a
Maximum no. of export cable trenches in corridor		6	n/a	n/a	n/a	n/a	n/a	n/a
Maximum no. HDD bores at beach for cable pull-in		8	n/a	n/a	n/a	n/a	n/a	n/a

10.288. Of the gull species of High sensitivity, Kittiwake, Lesser Black-backed Gull and Herring Gull were typically recorded in flight, and are not considered sensitive to boat traffic (Garthe & Hüppop 2004, Furness & Wade 2012). This was also the case for Gannet. Thus the impact of displacement through disturbance by increased boat traffic is predicted to be of negligible magnitude with a resulting impact of minor and **not significant** (Table 10.10).

10.289. Puffin had the highest proportion of birds on the water (90%) amongst the sensitive receptors recorded in Project Alpha. Furness & Wade (2012) do not consider Puffin as particularly sensitive to disturbance, which is supported by the fact that only 3% of birds (54 individuals) dived to escape and <1% (15 individuals) flushed into flight at the approach of the survey vessel. Therefore, the impact is considered to be of negligible magnitude giving a significance of minor and **not significant** (Table 10.10).

10.290. The other auks, Guillemot and Razorbill also tended to be recorded on the water rather than in flight, with both species considered both to be more sensitive to disturbance to Puffin by both Garthe & Hüppop (2004) and Furness & Wade (2012). However, data derived from within Project Alpha reveal that like Puffin, <1% of birds of either species on the water flushed as the vessel approached, whereas 3% of Guillemots and 5% Razorbills escape-dived. As such, the data gathered specifically for Project Alpha suggests a similar magnitude of disturbance to Puffin. A negligible magnitude therefore predicts a minor and **not significant** impact of disturbance by increased boat traffic on Guillemot and Razorbill (Table 10.10).

10.291. The Medium sensitivity Great Black-backed Gull and Arctic Tern were also both predominantly recorded in flight, with neither considered sensitive to disturbance (Garthe & Hüppop 2004, Furness & Wade 2012). The magnitude of the impact on both Great Black-backed Gull and Arctic Tern is therefore negligible, which means the predicted significance of the impact of disturbance from increased boat traffic is negligible and **not significant** (Table 10.10).

10.292. Confidence in the assessment of displacement in the construction phase of Project Alpha is considered to be high. Whilst specific studies on the reaction of birds to boat traffic associated with offshore wind farms would be welcomed, it remains unlikely that predictions would change substantially.

Mitigation

Mitigation
A code of conduct for vessel operators is recommended to help reduce disturbance of seabirds. Guidance on avoiding large rafts of birds and/ or feeding aggregations will be provided.

Residual Impact

10.293. Good practice by vessel operators is not considered to further substantially reduce the impacts on the nine sensitive receptors, although it would potentially reduce any effect upon individual seabirds on each occasion conducted.

Indirect effects of construction on prey

10.294. The construction of offshore wind farms can cause noise and vibration disturbance to fish particularly through pile driving (e.g. Caltrans 2001). Noise disturbance can have several impacts on fish from mortality or physiological damage, disturbance to spawning and feeding patterns and displacement (Thomsen *et al.*, 2006). These potential impacts on fish populations can have indirect effects on the seabirds, which prey upon them (see Perrow *et al.*, 2011).

10.295. As hearing specialists, clupeids (Herring and their allies) that form part of the diet of most of the sensitive receptors (see BWPi 2004, Ouwehand *et al.*, 2004, Wanless *et al.*, 2005b, Harris & Wanless 2010) are thought to be particularly vulnerable. Chapter 12: Natural Fish and Shellfish Resource considers the potential impact of the construction phase of Project Alpha and Project Bravo in detail. The potential impacts on Project Alpha were considered on a species level, whereas Seagreen Project cumulative impacts were considered in more general terms. The main findings, relevant to ornithology were:

- for Sandeel, a further key component of the diet of the sensitive species in the Firth of Forth (Wanless *et al.*, 1998, BWPi 2004) the impact of noise from construction causing death or irreversible damage is predicted to be negligible, with a range below the level of detection for auditory injury;
- for Herring (or Sprat), a hearing specialist, the range at which auditory injury may occur was estimated at 260m was and a minor adverse impact was predicted;
- the impact of noise from construction on behaviour, in particular spawning was considered as negligible for sandeel, but minor adverse for Herring, stemming from a maximum impact range of 28km for a strong avoidance reaction;
- overall, the cumulative impact of the Seagreen Projects in regard to disturbance or damage caused by noise during construction and operation was considered to be minor adverse for Herring; and
- the potential impact of habitat loss of sandeel was considered to be of negligible adverse significance, with disturbance to seabed habitat through the Seagreen Projects considered to be no higher than minor adverse.

10.296. An impact of construction noise is generally considered to be both temporary and short term, with reorientation of fish after each piling event and between periods of piling activity. However, should the spawning stock be affected, both recruitment of young fish in the current season and future seasons may be affected (Perrow *et al.*, 2011). Moreover, given the likelihood for more favourable weather for piling over the breeding seasons of the birds, there could be a high degree of overlap.

10.297. Five of the sensitive receptors have been considered for the potential impact of indirect effects of construction on prey. These are breeding Kittiwake, Guillemot, Razorbill and Puffin, with Arctic Tern typically occurring on passage.

10.298. Tracking studies of the breeding species considered for this potential impact revealed that the core foraging areas were outside that of the Project Alpha site boundary (see Sensitive species above), thereby reducing the impact of indirect effects on prey availability, still further from the overall minor adverse impact from noise for the cumulative Seagreen Projects on the most sensitive fish species.

10.299. However, given that the maximum impact range for strong avoidance reaction or behavioural changes for Herring / Sprat is 28km (see Table 12.18 in Chapter 12: Natural Fish and Shellfish Resource), there is potential for this component of the diet of all the sensitive receptors considered to be displaced from a wide area including the key foraging grounds of Scalp Bank, Wee Bankie and Marr Bank (Plot 10.5).

10.300. Based on the 28km radius from each pile, an area of 2,467km^2 would be affected. This was expressed as a proportion of the available habitat based on the mean maximum foraging + 1SD range of each species (Table 10.25) that ensured that the range of each species observed on both sites during the breeding season was encapsulated. For the purposes of assessment it was assumed that all of the area affected fell within range of a generic pile, even though this may not have been the case for piles further from shore. Moreover, it was assumed that there was no cumulative or synergistic effect of piling, in that one piling event was independent of the next. This may be broadly true unless a proportion of the stock is lost each time either through mortality, or permanent rather than temporary displacement.

Table 10.25 Potential foraging area of each breeding species from each linked colony as calculated from mean maximum +1SD foraging range (Thaxter *et al*., 2012), and the area lost (%) according to the impact range of piling upon Herring / Sprat (28km).

Species	Foraging range (km)	Colony			
		Fowlsheugh		Forth Islands	
		Foraging area (km^2)	% affected	Foraging area (km^2)	% affected
Black-legged Kittiwake	83.3	11,878	21	9,911	25
Common Guillemot	134.3	34,266	7	22,582	11
Razorbill	83.5	11,934	21	9,947	25
Atlantic Puffin	151.4	0	0	28,591	9

10.301. Subtle variation in the amount of foraging area available at each site for each species measured in GIS occurred as a result of the contours of the coast. The loss in foraging habitat was highest for the species with smaller ranges. Thus, for Razorbill and Kittiwake, 21% of habitat may be affected for birds from Fowlsheugh SPA with 25% lost from Forth Islands SPA (Table 10.25). The loss derived from Percival *et al. (*1999) in both cases is of high magnitude (Table 10.9).

10.302. For Guillemot and Puffin, with larger foraging ranges, losses are reduced to between 7% and 11% for Guillemot from Fowlsheugh and the Isle of May within Forth Islands SPA respectively, with 9% for Puffin from the Isle of May (Table 10.25). The magnitude of the effect of habitat loss for each species at any colony is of medium magnitude (Table 10.9).

10.303. In contrast to Herring / Sprat, as hearing generalists sandeels are considered to have an impact range for strong avoidance reaction or behavioural changes of just 200m (see Table 12.18 in Chapter 12: Natural Fish and Shellfish Resource). A total of 0.125km^2 would thus be affected around each turbine, with 9.42km^2 from the 75 WTGs installed within each Project, under the worst case assumption that the area around each WTG would be permanently affected. Even under the worst case, this equates to <0.1% of habitat loss from the key colonies of any species (Table 10.26). The magnitude of effect in all cases is negligible (Table 10.9).

10.304. The magnitude of the effect and the ultimate significance of the impact of piling is therefore linked to the relative importance of Herring/ Sprat relative to sandeels for the seabirds concerned.

Table 10.26 Potential foraging area of each breeding species from each linked colony as calculated from mean maximum +1SD foraging range (Thaxter *et al.*, 2012), and the area lost (%) according to the impact range of piling upon sandeel (0.2km).

Species	Foraging range (km)	Colony			
		Fowlsheugh		Forth Islands	
		Foraging area (km^2)	% affected	Foraging area (km^2)	% affected
Black-legged Kittiwake	83.3	11,878	0.08	9,911	0.10
Common Guillemot	134.3	34,266	0.03	22,582	0.04
Razorbill	83.5	11,934	0.08	9,947	0.10
Atlantic Puffin	151.4	0	0	28,591	0.03

10.305. Sandeels have historically been considered the key component of the diet of many of the seabirds breeding in the Firth of Forth (see Wanless *et al.*, 1998), to the extent that the decline in breeding numbers of seabirds in Scottish colonies, especially Kittiwake, has been linked to the decline of sandeels in the North Sea (Frederiksen *et al.*, 2004). To aid recovery the commercial fishery in the Firth of Forth was closed in 2000. Despite the closure, apart from an initial peak in biomass, the sandeel stock had not recovered by 2009 for unknown reasons (Greenstreet *et al.*, 2010). Further analysis of showed that Kittiwake was most sensitive to changes in sandeel abundance, as initially suggested by Furness & Tasker (2000), followed by Puffin and Razorbill. Guillemot was less sensitive (Daunt *et al.*, 2008). Only for Kittiwake was breeding performance linked to abundance of 1+ and 0-group sandeels. In relation to the latter, the proportion of the 0-group consumed by Kittiwakes and the proportion of the population foraging in the area concerned was directly linked to the abundance of 0-group sandeels (Daunt *et al.*, 2008).

10.306. In general terms, the importance of sandeel to the seabirds breeding in the Firth of Forth region (Wanless *et al.*, 1998) means that as long as sandeels remain mostly unaffected by the development and that sufficient stock is present, construction noise may be relatively unimportant. However, the lack of dependence of most species, upon sandeels, apart from Kittiwake, suggests that Clupeids may be more important than often thought or become more important in future, especially if sandeels do not recover from the closure from the fishery, perhaps as a result of warming seas that seem to disfavour sandeels (Arnott & Ruxton, 2002, Frederiksen *et al.*, 2007, Heath *et al.*, 2009).

10.307. Indeed, clupeids have already being selected in some years as a result of the low availability of sandeels (e.g. Wanless *et al.*, 2005b). Reduced breeding success was observed in 2004 when Guillemot on the Isle of May selected Sprat, but this seemed to be the linked to the poor energy content of the fish in that year (linked to poor feeding conditions for several shoaling fish species) rather than linked to the lack of suitability of Sprat *per se*. Moreover, poor breeding performance is noted in more northerly colonies where there appears to be greater dependence upon sandeels, with recent evidence of redistribution of seabirds to more southerly locations such as Flamborough Head and Bempton Cliffs, where populations of many species are increasing (see Baseline Technical Report - Volume III Appendix F1).

10.308. Overall, there is uncertainty over how seabirds may respond to the indirect effects of construction upon fish, although this is likely to be magnified from the predicted impacts upon the fish themselves (see 10.295 above). The reason for this is that although fish, especially Herring / Sprat are predicted to redistribute with little affect upon their populations, redistribution of fish away from core foraging habitat for breeding seabirds that are range-limited, may be a serious issue for breeding productivity. The lengthy duration of noisy construction over several years is also of particular consequence.

10.309. Nonetheless, the dependence of Kittiwake upon sandeels suggests that the magnitude of effect is more likely to be negligible (see 10.303 above) than high (see 10.301). With a negligible magnitude of effect, the significance of impact would be predicted to be minor and **not significant** for Kittiwake at all colonies.

10.310. For the other species the displacement of clupeids may increase the pressure on sandeels and although this have a negligible effect should sandeel abundance by maintained, this seems unlikely in the current climate and the magnitude of effect is more likely to be low. As a result, the predicted significance of impact has to be considered to be moderate and **significant** for high sensitivity Puffin, Razorbill and Guillemot at all breeding colonies.

10.311. The foraging area available to Arctic Tern, that is mainly on passage and therefore not subject to central-place foraging from a colony, is suggested to encompass the entire Firth of Forth, which may be seen to be a minimum of 5,754km^2 as the area surveyed by aerial surveys. Should Arctic Tern be dependent on sandeels, some 0.16% of foraging habitat may be lost. This is of negligible magnitude and thus of negligible significance. Alternatively, a dependence on clupeids would suggest a loss of up to 43% of foraging habitat, producing a high magnitude of effect, which combined with the medium sensitivity of Arctic Tern, suggests an impact of major significance.

10.312. In truth, there is no data on the relative importance of one fish species over another for Arctic Tern on passage. The assumption that sandeels and young Herring/ Sprat are of equal significance would result in moderate magnitude of effect. Given that Arctic Tern is also on passage and seemingly not specifically dependent on the resources in the Firth of Forth, and bearing in mind that the species will also feed on invertebrates that would be probably be unaffected by construction noise, a low magnitude of effect is thought to be more realistic. Combining this with the medium sensitivity of Arctic Tern suggests the potential impact is minor and **not significant**.

Mitigation

Mitigation
At this stage, no mitigation other than the use of best practice in piling (i.e. soft start) is assumed.

10.313. Currently the only technically and economically feasible installation methodologies for wind turbines require a certain amount of pile driving. Although pile driving mitigations have been developed, there is currently no method suitable for jacket substructure/ foundations in deep water. However, currently there is extensive work under way within the industry looking into both potential noise mitigation methods for piling as well as alternative non-piled substructure/ foundation solutions. Seagreen is actively involved in this process but until new evidence is presented no mitigation can be adopted.

Residual Impact

10.314. As stated above, at this stage no mitigation other than the use of best practice approaches to pile driving have been adopted within this assessment and therefore the impacts will not be below those already assessed.

Project Bravo

Displacement through disturbance due to increased boat traffic

10.315. The potential impact of displacement in the construction phase through the disturbance of birds as a result of increased boat traffic for Project Alpha can be considered the same in Project Bravo. Whilst the proportion of birds in flight varies between Project Alpha and Project Bravo and there is some minor variation in the proportion of flushed auks, the overall effect is unchanged. Therefore the impact of displacement through disturbance due to increased boat traffic on Kittiwake, Lesser Black-backed Gull, Herring Gull, Gannet Guillemot, Razorbill and Puffin is considered to be minor and **not significant**. Predicted impact of displacement on Great Black-backed Gull and Arctic Tern is thought to be negligible and **not significant**.

Mitigation

Mitigation
As in Project Alpha, a code of conduct for vessel operators is recommended to help reduce disturbance of seabirds. Guidance on avoiding large rafts of birds and/or feeding aggregations will be provided.

Residual Impact

10.316. Good practice by vessel operators is not considered to further substantially reduce the impacts on the nine sensitive receptors, although it would potentially reduce any effect upon individual seabirds on each occasion conducted.

Indirect effects of construction on prey

10.317. The impact of indirect effects of construction on prey is considered to be the same at Project Bravo as at Project Alpha. In summary, an effect of low magnitude is predicted and thus an impact of moderate and **significant** for high sensitivity breeding Guillemot, Razorbill and Puffin at Fowlsheugh and/or Forth Islands SPA. A negligible magnitude is predicted for Kittiwake that is dependent on sandeels, which results in an minor and **not significant** impact despite its high sensitivity. Similarly minor and **not significant** impacts are predicted for Arctic Tern using the area as a stopover after breeding and during autumn migration, from a combination of low magnitude with medium sensitivity.

Mitigation

Mitigation
As described for Project Alpha, at this stage no mitigation other than the use of best practice in piling (i.e. soft start) can be offered.

Residual Impact

10.318. As for Project Alpha, best practice is assumed not to reduce any impact below that already assessed.

Transmission Asset Project

Infrastructure within the Project Alpha and Project Bravo site boundaries

Disturbance and displacement during construction

10.319. A minimum period of time for the offshore wind farm substructure and foundation installation would be six months for the purposes of the assessment. It is assumed that installation of two foundations/ substructures per wind farm site could be on-going at the same time. However, if installation involves piling operations, only one operation will be on-going within each site at any one time.

10.320. The worst case scenario considers the installation of up to five OSPs (four AC collector stations and one DC converter station) using pile driving. The DC converter station platform will have up to 12 legs with 2 piles per leg (total 24 piles). AC collector platforms will have up to 6 legs with 2 piles per leg (total 12 piles). This gives a total of up to 72 piles required in the construction period for the transmission asset project.

10.321. The whole operation to install one tubular pile takes approximately 13 hours, including positioning the installation vessel and the piling hammer, placing the template or substructure and aligning the pile. Within this overall period the pile driving activity takes place over approximately 1 hour, depending on ground conditions.

10.322. The maximum number of piles for the DC converter station and the four AC collector stations is 72. Thus, an approximation of the minimum pile driving time for OSP installation would be in the region of 72 hours (over approximately 39 days). This represents a relatively small proportion of the 6 months total substructure / foundation installation time. The OSP deck and topside structures are likely to be installed via floated crane vessel (self-propelled or towed).

10.323. In relation to the species affected, the large foraging range of Gannet combined with their predation on a relatively wide spectrum of prey implies that Gannets are unlikely to be significantly affected by localised construction effects. The magnitude of any disturbance effect on this species is therefore considered to be of negligible magnitude, resulting in a predicted minor and **not significant** impact.

10.324. Opportunistic scavenging species such as gulls may benefit from foraging opportunities created by construction works. Great Black-backed gull, for example, frequently associate with vessels and human activity (e.g. fishing activity) (Mitchell *et al.*, 2004) and may exploit novel foraging opportunities created by construction activities that may make prey more available to them. As such, the magnitude of the potential impact on Great Black-backed gull and Kittiwake is considered to be negligible. This leads to significance of impacts of negligible and minor respectively, both **not significant**.

10.325. Auks were observed in relatively large numbers throughout the ECR particularly during the breeding period. The limited extent of the construction period of the ECR in terms of temporal and spatial spans suggests that impacts by disturbance will be of a negligible magnitude. On this basis the impact is considered to be minor and **not significant** for Guillemot and Puffin and negligible and **not significant** for Razorbill.

Indirect effects

10.326. The worst case scenario includes five OSPs for the Seagreen Project (four collector stations and one converter station). If gravity base structures are used, scour protection (rock placement) will be installed around each OSP base. The total indicative worst case habitat loss (sum of the footprints for GBS, plus scour protection: the 'permanent zone of influence) is 29,365m^2 for five OSP structures. Habitat loss associated with OSPs is also discussed in the benthic impact assessment (Refer to Chapter 11: Benthic Ecology and Intertidal Ecology).

10.327. The jack-up vessel for offshore installation activities is assumed to have six legs, with each leg covering a 4.5 m^2 footprint (typical penetration 2 m). This suggests that the total area of habitat temporarily disturbed by the installation vessel at any one time will be a minimum of 27 m^2.

10.328. The extent of permanent habitat loss if GBS are used, in addition to the extent of temporary habitat disturbance due to installation vessels, is relatively small in comparison to the total area occupied by turbine foundations and scour protection. Therefore, effects on distribution and abundance of bird prey species are not considered likely to be significant and are not deemed to require further assessment in terms of OSPs.

10.329. Considering that pile driving is the most likely installation method the OSP foundations, potential increases in suspended sediments during the construction and decommissioning phases are not considered likely to be significant. Potential increases are also likely to be short term and temporary, given the installation timeframe for OSPs. Therefore, suspended sediment impacts on bird prey species as a result of OSP installation are also not considered significant, and are not deemed to require further assessment.

10.330. If pile driving is used to install the OSPs, the maximum number of piles for the 12-leg DC converter station platform and the four 6-leg AC collector platforms is 72 piles. The maximum pile driving time is in the region of 72 hours, and the noise effects of this may have implications for prey fish species. Mobile fish species are likely to move away from significant noise sources, such as the pile driving location. However, given the temporary and short term nature of the OSP installation period, it is not considered that the associated potential noise effects will adversely affect prey fish species. The most likely effect of pile driving on prey fish species is a short term displacement, and this is not considered to be significant given the duration of effect and location of activity. As such, potential noise effects on prey fish species are not considered to require further assessment.

Export Cable Route (ECR) Corridor

Disturbance and displacement during construction

10.331. Indicative cable installation rates (see Transmission Asset Project Technical Report, Volume III Appendix F2) suggest that the installation period for the export cable is significantly less than the construction period for the wind farm itself. Therefore, disturbance to ornithological receptors as a result of installation vessel activity will be temporary and localised. Using the trenching rates indicated in Chapter 5: Project Description (Table 5.17), installation of the export cable could be completed in a nine month period. Displacement effects arising from the presence of the cable installation vessel are considered to be temporary and localised, and not likely to result in prolonged displacement of bird species.

10.332. The time-span for installation of the ECR is limited, with the main potential impacts arising from increased vessel presence. Gannet has a large foraging range and is not known to be sensitive to disturbance from vessels and often follows fishing boats for foraging opportunities (Nelson, 2002). The magnitude of any disturbance effect on this species is therefore considered to be of negligible magnitude, resulting in a predicted minor and **not significant** impact.

10.333. As with construction of the OSPs, opportunistic scavenging species (such as gulls) may benefit from the foraging opportunities created by construction activity within the ECR. As such, the magnitude of the potential impact on Great Black-backed gull and Kittiwake is considered to be negligible. This leads impacts of negligible and minor respectively, and therefore both are considered to be **not significant**.

10.334. Auks were observed in moderate numbers within the offshore elements of the ECR. Direct observations of foraging by guillemot and presumed return flights by razorbill towards Fowlsheugh SPA in the surveys of Project Alpha and Bravo, suggest that the area has some importance for these species. The limited temporal and spatial extent of the ECR construction period suggests that impacts by disturbance will be of a negligible magnitude. On this basis the impact is considered to be minor and **not significant** for Guillemot and Puffin and negligible and **not significant** for Razorbill.

Indirect effects

10.335. Habitat loss associated with export cable installation is not considered likely to be permanent or significant, since sediments moved in trenching will be used to refill the cable trench. Habitat disturbance is estimated to extend to the 1km width of the ECR, but it is not considered likely that this disturbance will have a significant impact on prey availability for bird species.

10.336. The potential noise impacts of cable installation on birds or their prey fish species are not as well quantified as those related to offshore foundation and substructure installation. However, cable installation by ploughing, trenching or cutting does not produce the same level of noise associated with pile driving. Therefore, potential noise impacts on bird prey species from cable installation are not considered to be significant, and are not deemed to require further assessment.

10.337. Suspended sediment concentrations resulting from cable installation activity will depend on the substrate type along the route. Any increases are likely to be limited, short term and temporary – although increases would be higher in finer sediment regions. The small area of seabed disturbance due to cable installation activity, combined with the short term nature of installation activity (i.e. potentially within 9 months), make the likelihood of significant suspended sediment impacts on bird prey species low. Further assessment of these impacts is not deemed to be required.

10.338. Cable installation involves some limited disturbance of seabed sediments along the ECR, and therefore there may be some small scale changes in abundance and distribution of bird prey species. Considering the small areal extent of seabed disturbance, and the short term duration of installation activity, changes in prey abundance and distribution are not likely to be significant, or to require further assessment.

Summary of the effects of the construction phase

10.339. Table 10.27 provides a summary of the significance of all effects during the construction phase of the Transmission Asset Project.

Table 10.27 Summary of the significance of all effects in the construction phase of the Transmission Asset Project

Species	Sensitivity	OSPs		ECR corridor	
		Disturbance	Indirect effects	Disturbance	Indirect effects
Gannet	High	Minor	Minor	Minor	Minor
Kittiwake	High	Minor	Minor	Negligible	Minor
Great black-backed gull	Low	Negligible	Negligible	Negligible	Negligible
Guillemot	High	Minor	Minor	Minor	Minor
Razorbill	Medium	Negligible	Negligible	Negligible	Negligible
Puffin	High	Minor	Minor	Minor	Minor

IMPACT ASSESSMENT – OPERATION

Project Alpha

Displacement during operation

10.340. The potential impact of displacement during the operational phase of Project Alpha focuses on seabirds avoiding or being displaced from within the site. Displacement is considered as a long-term impact, persisting throughout the operational phase, although some seabirds may become habituated to the site. Four sensitive receptors have been considered for this impact, namely, Kittiwake, Guillemot, Razorbill and Puffin. All four sensitive receptors are of high sensitivity.

10.341. Experience of the response of birds to operational sites has shown that birds will utilise habitat within the wind farm (Krijgsveld *et al.*, 2011, Lindeboom *et al.*, 2011), even including sensitive species that initially avoided the site (e.g. Petersen & Fox, 2007). In surveys in the UK (*pers obs*) Guillemot for example, have been observed on the water within 50m of turbine bases within operational sites and densities of the auk appeared to be unaffected at 400m or more from the base of turbines. Using an avoidance distance of 400m from turbine bases (including 7m in diameter for the turbine base – see Chapter 5: Project Description), Guillemot would be displaced from only 16.9% of the Project Alpha footprint, based on either the indicative or optimised layouts (Figures 5.1 and 5.2 for Chapter 5: Project Description). This avoidance distance has been used for all three auks considered for displacement.

10.342. In regard to Kittiwakes, mainly recorded in flight, the distance from the turbine bases at which densities appeared unaffected was reduced to 300 m. This equates to displacement from 9.9% of the Project Alpha site (either layout).

10.343. For Guillemot, the peak population estimate of 10,811 birds (June 2011 – Plot 10.14) was recorded during the breeding season within Project Alpha. Using the population matrix (Table 10.14), displacement from 16.9% of the site resulting in 100% mortality would affect 0.09% of the national population (1,420,900 multiplied by 1.5 to account for birds of all ages). A more realistic mortality rate of 1% would affect only 0.001% of the population (see Appendix F3 details of the risk matrix of displacement in ES Volume III). Therefore the magnitude of the impact would be negligible. In regard to the population of birds at designated colonies (assuming all birds in the peak population originate from the colony), 1% mortality would be the impact on 0.01% of the population (130,810 individuals) and thus also be of negligible magnitude.

10.344. The peak Razorbill population was recorded during the breeding season in July 2011, with 2,102 individuals recorded within Project Alpha (Plot 10.16). Based on the unrealistic scenario of 100% displacement resulting in 100% mortality, 0.74% of the national breeding population (188,576 breeding birds according to Baker *et al.*, 2006 multiplied by 1.5 to account for non-adult birds) would be affected. Using the more practical scenario of the peak population being displaced from 16.9% of Project Alpha resulting in 1% mortality, 0.001% of the national population would be affected. Thus, the resultant magnitude of the impact would be negligible. Based on the assumption that all individuals in the peak population originated from designated colonies within foraging range (mean maximum from Thaxter *et al.*, 2012), displacement from 16.9% of the site resulting in 1% mortality would affect 0.05% of the population. Again, the magnitude of effect is negligible.

10.345. The peak population estimate for Puffin was also recorded during the breeding season. The maximum population estimate was 2,787 birds in June 2011 (Plot 10.18). Based on displacement of 16.9% of the Project Alpha footprint, 1% mortality would impact on 0.0003% of the national breeding population (1,161,598 breeding birds according to Baker *et al.*, 2006 multiplied by 1.5 to account for non-adult birds) and thus a negligible magnitude of effect. If all birds within Project Alpha in the peak population were from designated colonies within foraging distance (199,007 individuals), 0.002% of the population would be affected as a result of a mortality rate of 1% and displacement from 16.9% of the Project Alpha footprint. An negligible magnitude resulting in a minor and **not significant** impact is predicted.

10.346. The proportion of the population affected by such displacement does not however take into consideration either the extent or importance of the foraging ground lost through the construction of Project Alpha. For example, the area of Project Alpha constitutes 1.6% and 4.8% of the total foraging area from Fowlsheugh for Guillemot and Razorbill respectively and 1.4% of the foraging area from the Isle of May for Puffin (derived from mean maximum from Thaxter *et al.*, 2012). This equates to a low magnitude of the effect of habitat loss for birds based at any single colony.

10.347. Tracking studies from the Isle of May for both Guillemot and Razorbill indicate that the area within Project Alpha does not constitute part of the core foraging area (50% kernel) for either Guillemot (Plot 10.29) or Razorbill (Plot 10.30) in 2010 or in previous years with different foraging conditions (Daunt *et al.*, 2011c). This reinforces the view of a low magnitude of effect.

10.348. Flight direction analysis of Guillemot within Project Alpha suggested that the birds present were most likely to originate from Fowlsheugh. Trip duration analysis at Fowlsheugh suggested that mean foraging range was 12km to a maximum of 56km. It seems likely that core foraging habitat would be at closer distance to the colony than the ~30km distance to Project Alpha. The suggestion that Project Alpha falls outwith core foraging habitat of both Guillemot and Razorbill is reflected by the fluctuations in population size of both species (Plots 10.14 & 10.16 respectively) on the sites.

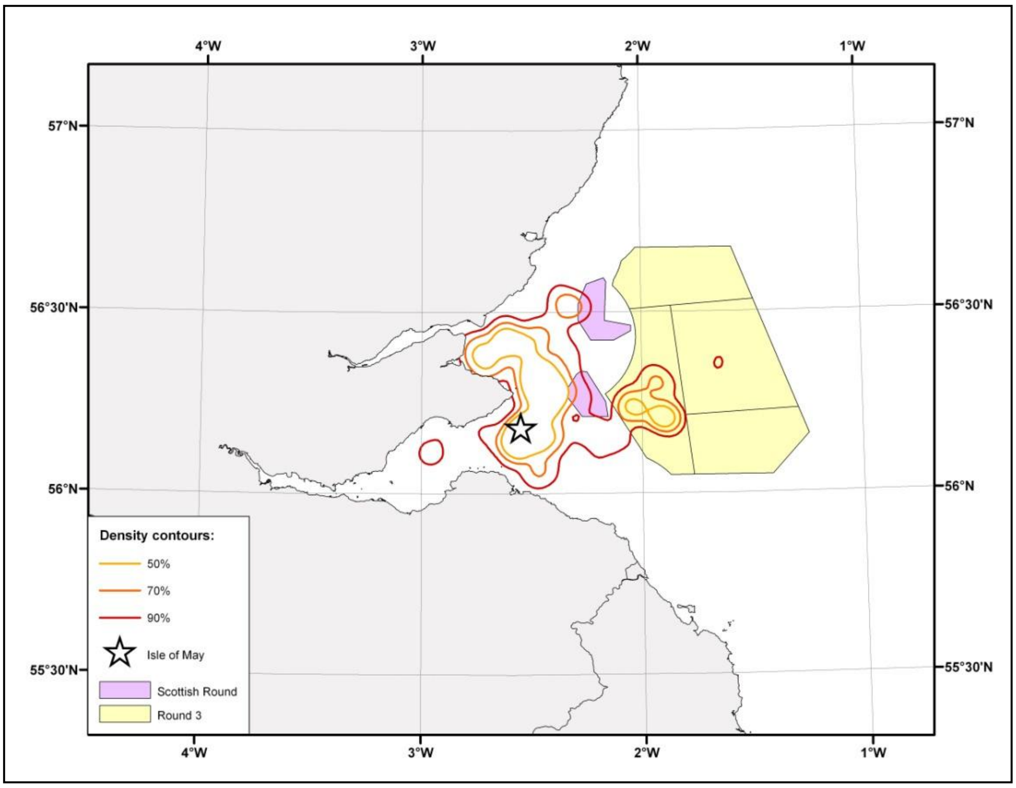
10.349. There is little available data for Puffin, although tracklines typically fell short of Project Alpha (and Bravo) and populations in the site were generally rather low apart from a peak in June (Plot 10.19). It would again seem that core foraging area for Puffin does not include

Project Alpha, reinforcing the suggestion that the magnitude of effect of displacement is likely to be of low.

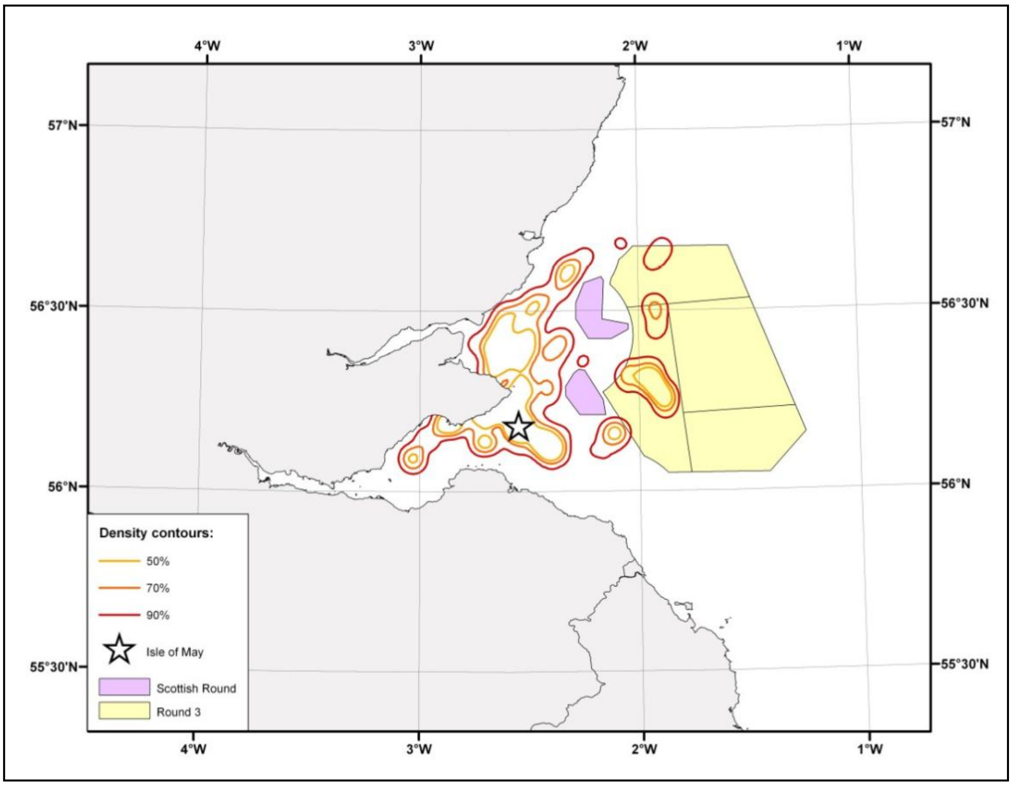
10.350. In relation to Kittiwake, the peak population of 4,493 individuals in the winter was assessed in the first instance. With 9.9% displacement from Project Alpha footprint resulting in a 1% mortality rate, only 0.0004% of the national population (1,139,676 individuals) would be affected. This equates to an impact of negligible magnitude. For the maximum population of 1,925 individuals in the breeding season under the same conditions, 0.005% of the population of the designated colonies (38,840 individuals) would be affected, again suggesting a negligible magnitude.

10.351. The proportion of GPS fixes from Fowlsheugh in 2011 and the Isle of May in 2010 within Project Alpha was similar at 3.6% and 3.3% respectively suggesting that the representation within the site would be broadly related to the size of the colony (i.e. 28,386 individuals at Fowlsheugh in 2009 and 5,370 individuals in the Forth Islands SPA in 2011. Dividing the peak population accordingly between Fowlsheugh and the Isle of May according to displacement of 9.9% from Project Alpha resulting in a 1% mortality rate, 0.003% and 0.02% of the population of Fowlsheugh and the Isle of May respectively would be affected. The magnitude is therefore considered to be negligible.

Plot 10.29 Kernel density distributions (50%, 70% and 90%) derived from non-flight fixes of Guillemots breeding on the Isle of May fitted with GPS loggers in 2010 (taken from Daunt *et al*., 2011a). Note that Project Alpha and Project Bravo do not occupy the western part of the area of Phase 1 shown.



Plot 10.30 Kernel density distributions (50%, 70% and 90%) derived from non-flight fixes of Razorbills breeding on the Isle of May fitted with GPS loggers in 2010 (taken from Daunt *et al.*, 2011a). Note that Project Alpha and Project Bravo do not occupy the western part of the area of Phase 1 shown.



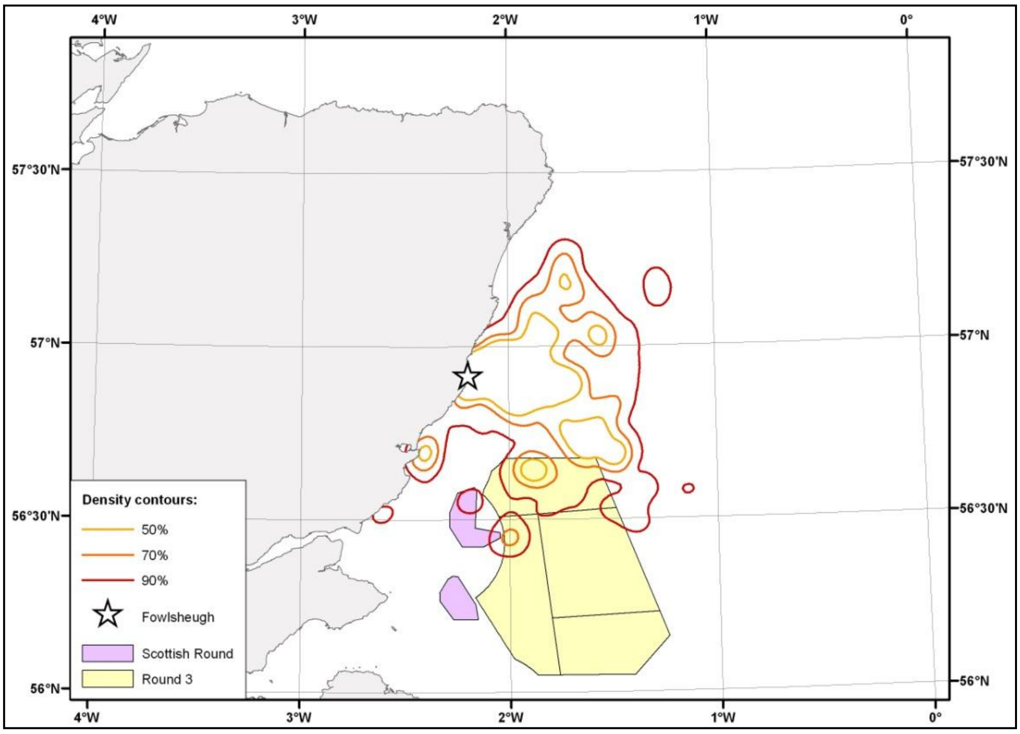
10.352. Using the proportion of the area of the Project Alpha footprint (197.2km^2) relative to the potential foraging area available according to the mean maximum foraging range of Kittiwake suggests that the proportion of foraging ground lost to birds from Fowlsheugh (11,878km^2 available) Isle of May (9,911km^2 available) and St. Abb's Head (11,560km^2 available) would only equate to 3.2%, 3.3% and 3.2% respectively. All values suggest a low magnitude of effect even if all of Project Alpha became unavailable (Table 10.9).

10.353. Moreover, tracking studies from both Fowlsheugh and the Isle of May suggest that Project Alpha does not fall within core foraging range of 50% kernel distribution although it falls within the 70% contour (Plots 10.31 & 10.32 respectively). Thus, there is effectively little to no displacement of birds from foraging habitat that is likely to underpin breeding performance even if all of Project Alpha is lost to them.

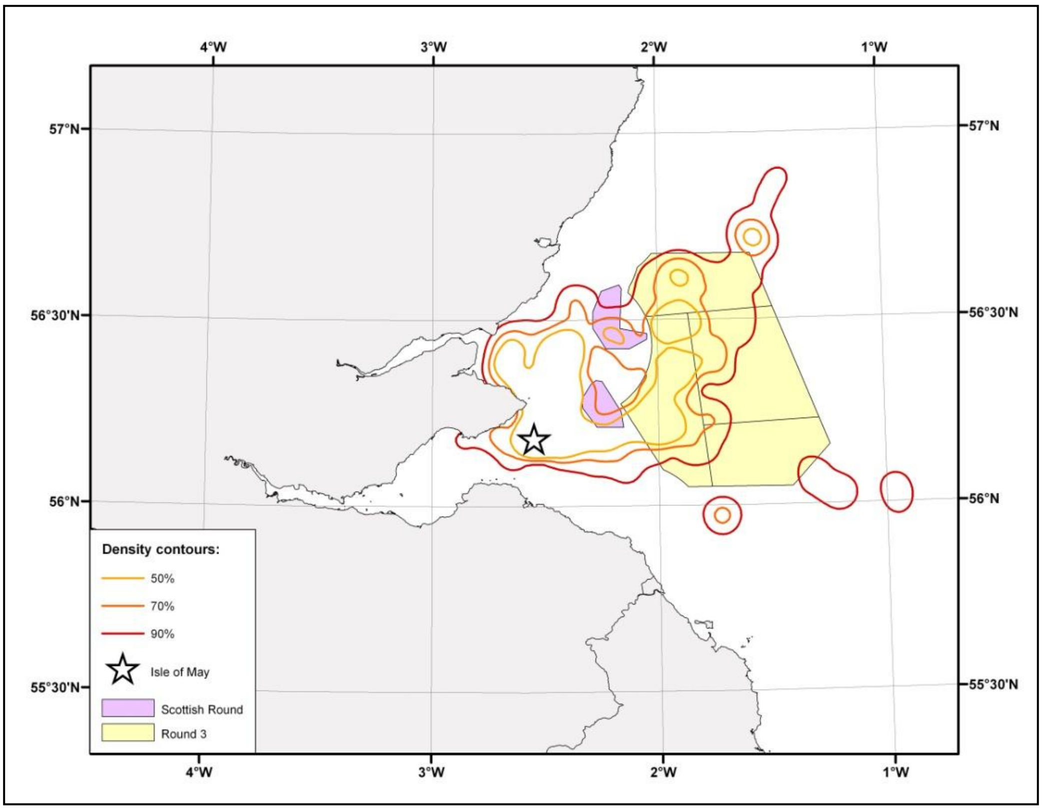
10.354. Overall, a range of criteria of the impact of displacement tend to reinforce the view of a negligible magnitude of effect which combined with the high sensitivity of Kittiwake resulting in an overall minor and **not significant** impact.

10.355. Confidence with the predicted impact of displacement from Project Alpha is relatively high. Further survey work to assess habitat within the site boundary would improve any assessment and has been suggested as part of the mitigation process below.

Plot 10.31 Kernel density distributions (50%, 70% and 90%) derived from flight and non-flight fixes of Kittiwakes breeding at Fowlsheugh fitted with GPS loggers in 2011 (taken from Daunt *et al*., 2011b). Note that Project Alpha and Project Bravo do not occupy the western part of the area of Phase 1 shown.



Plot 10.32 Kernel density distributions (50%, 70% and 90%) derived from flight and non-flight fixes of Kittiwakes breeding on the Isle of May fitted with GPS loggers in 2010 (taken from Daunt *et al*., 2011a). Note that Project Alpha and Project Bravo do not occupy the western part of the area of Phase 1 shown.



Mitigation

Mitigation
No mitigation for displacement effects are assumed at this stage.

10.356. Whilst the potential impact of displacement is not considered to be significant, any spacing between turbines less than the worst case assessed (see Chapter 5: Site Development) would reduce the footprint of the wind farm further. Areas that may be of value as foraging habitat to sensitive receptors, especially breeding birds in some years could potentially be avoided. Identification of these areas will however only be possible following detailed design of the wind farm.

Residual Impact

10.357. Avoidance of any areas of foraging habitat that may conceivably be used by the sensitive receptors, especially those originating from Fowlsheugh SPA, the closest colony to Project Alpha could effectively result in displacement impacts of negligible and **not significant**.

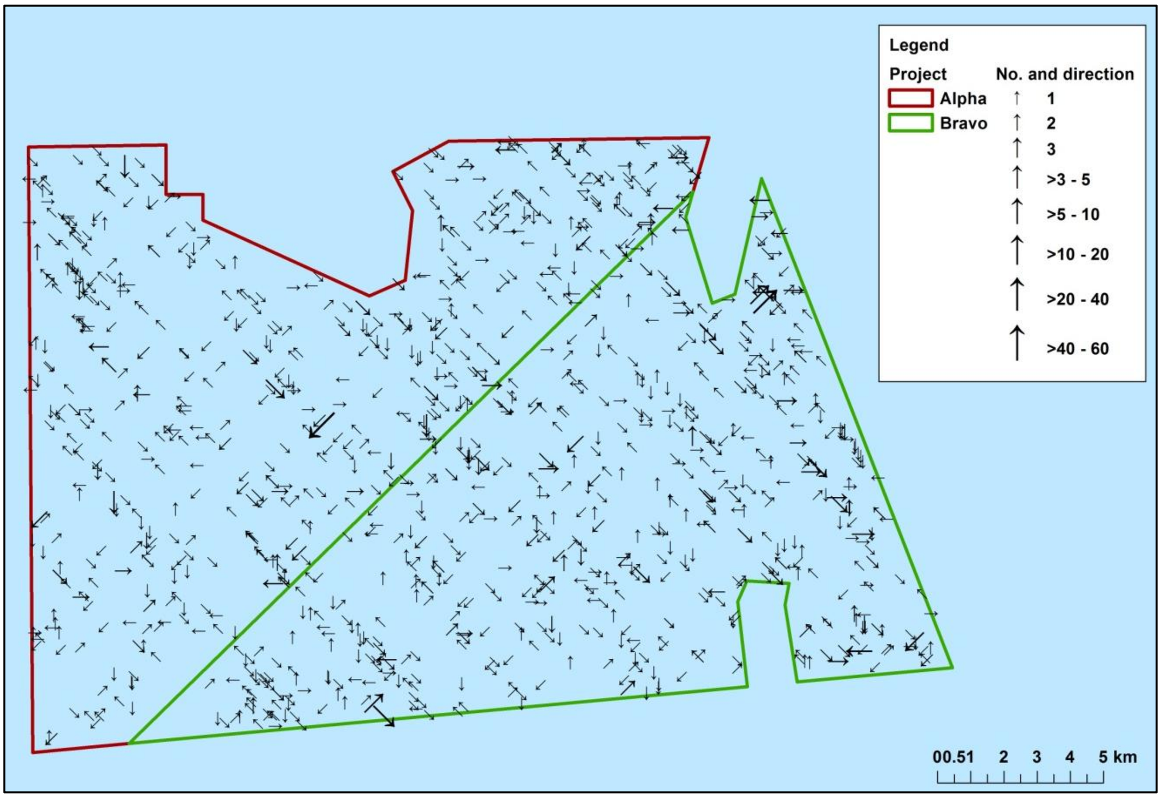
Barrier effects

10.358. Five species have been considered for the potential impact of barrier effects namely Kittiwake, Gannet, Guillemot, Razorbill and Puffin. All five sensitive receptors have High sensitivity.

10.359. For Kittiwake, birds in Project Alpha were thought to originate mainly from Fowlsheugh (at ~30km distant) with the potential for some birds from the Isle of May also reaching the site, although Project Alpha beginning at 53km from the Isle of May is towards the mean maximum foraging range of 60km. The origin of birds is reflected in the preponderance of northwest and southeast flights (33%) from and to Fowlsheugh, with some northeast and southwest flights (17%) from and to the Isle of May (Plot 10.33).

10.360. If Kittiwakes were from either Fowlsheugh or the Isle of May were unlikely to actually cross Project Alpha *en-route* elsewhere there would be no requirement to assess barrier effects in addition to the assessment of displacement. In this respect, the tracking studies in different years from both Fowlsheugh and the Isle of May provided essential information on core foraging areas as represented by 50% kernels (Plots 10.31 & 10.32). Birds from both colonies showed consistent use of an area in the north of Scalp Bank immediately to the west of Project Alpha, but also of Montrose Bank immediately to the northeast of the Projects at 84.4km from the Isle of May. Consideration of straight-line routes from colonies to reach these sites immediately reveals that only for the latter site would birds have to cross Project Alpha (or Project Bravo). Only for this scenario was there potential for a barrier effect.

Plot 10.33 Flight directions of Kittiwakes (n= 1,715) recorded in boat-based surveys in the breeding season of April to August in both Project Alpha and Project Bravo.

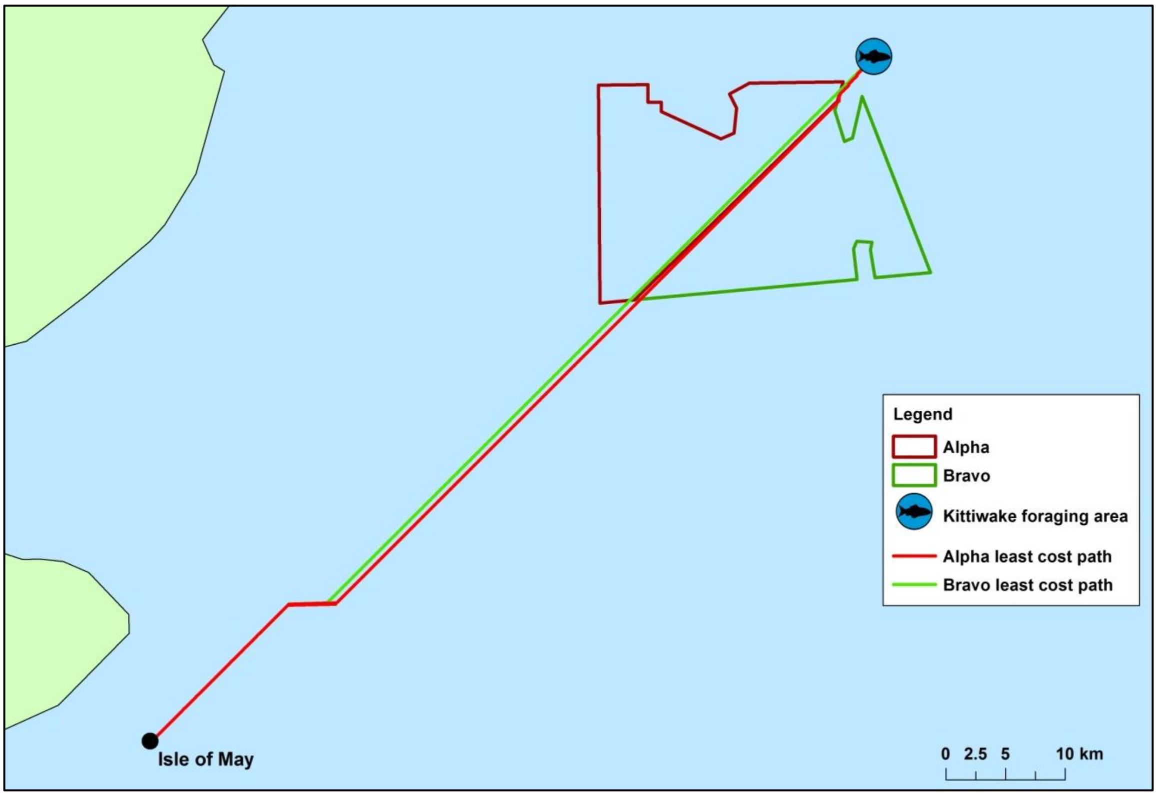


10.361. Comparison of the distances travelled to reach the foraging area both in the absence and presence of Project Alpha (Plot 10.34) assuming a least cost path was adopted to avoid the site according to the methods outlined in 10.148 above. This estimated an increased distance of just 0.937km (468.5m in each direction) per foraging trip that was initially 168.8km in length.

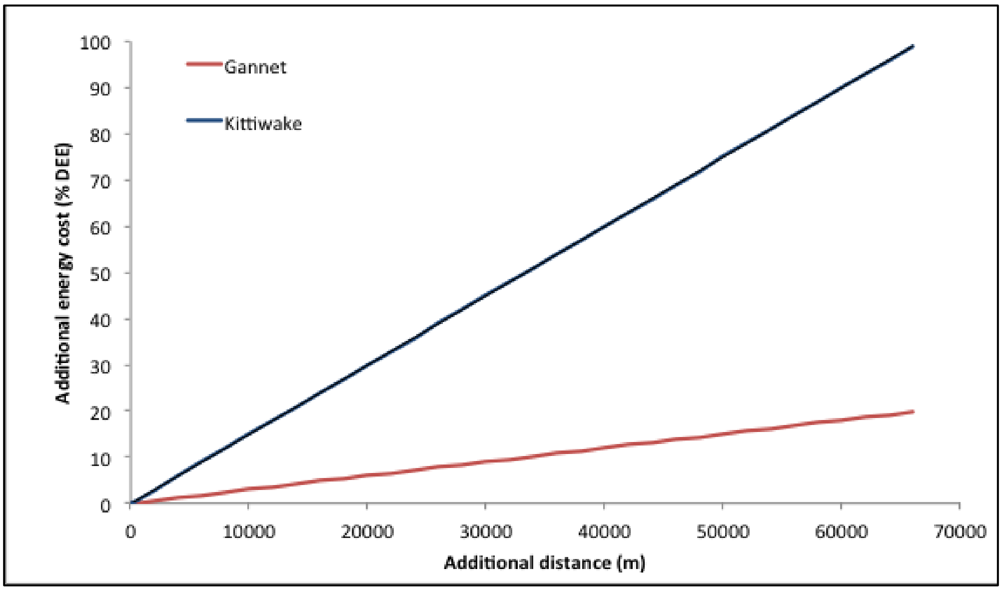
10.362. According to the relationship extrapolated from Masden *et al. (*2010) where additional energy cost = (0.0015 x additional distance [m]) - 0.08 (Plot 10.35) the additional daily energy expenditure of such a trip would be 1.3% and thus of negligible magnitude (see Table 10.16). The overall impact of barrier effects of Project Alpha on Kittiwake is thus predicted to be minor and **not significant**.

10.363. Flight directions of Gannet suggested that the birds recorded within Project Alpha were mainly heading to the northeast from Bass Rock with a reciprocal return to the southwest often involving birds in groups of up to ~60 birds (Plot 10.36). Such foraging trips could conceivably include Halibut Bank and Buchan Deep suggested to be important foraging areas for Gannets from Bass Rock by Camphuysen (2011), but in general appeared to match the area of Fladen Ground identified by Hamer *et al. (*2011) from data gathered in 2003 (Plot 10.37).

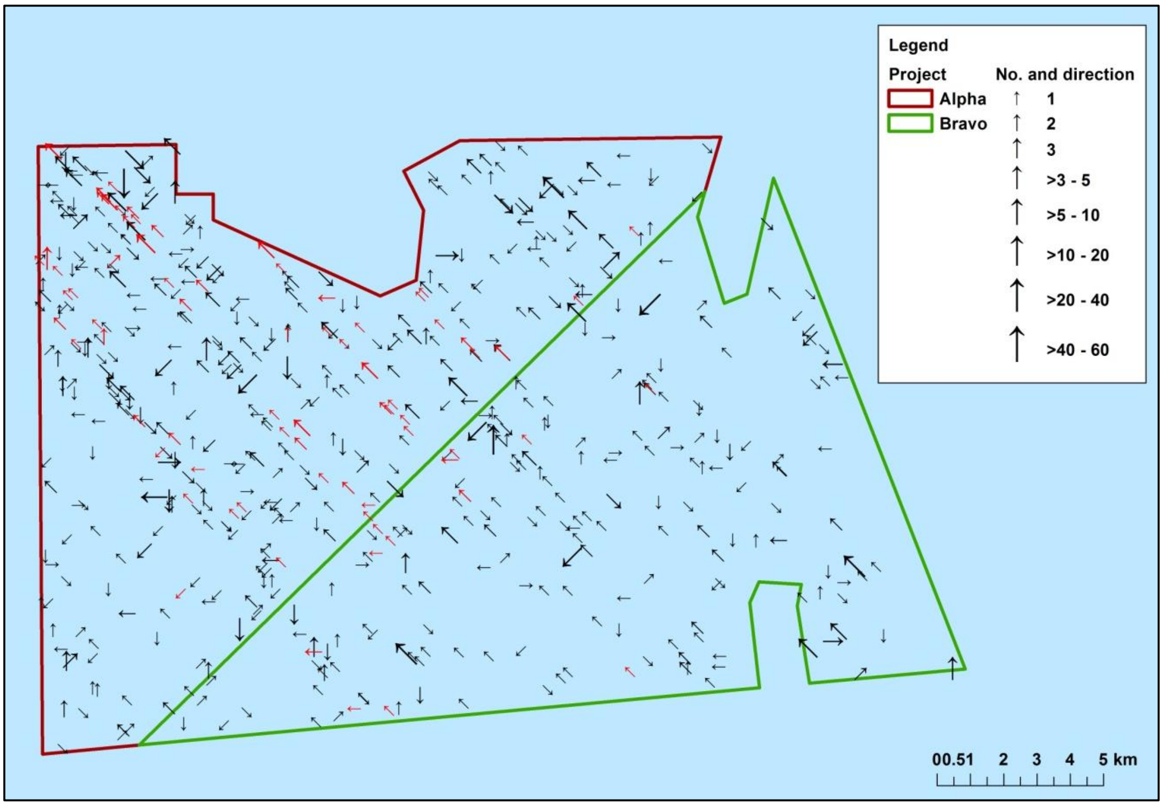
Plot 10.34 Predicted least cost path flight line of Kittiwake from the Isle of May to a known foraging area in the presence of either Project Alpha or Project Bravo in isolation.



Plot 10.35 Relationship between additional energy expenditure expressed as % of daily energy expenditure according to additional travelled (m) for both Kittiwake and Gannet. Data extrapolated from Masden *et al.* (2010).



Plot 10.36 Flight directions of Gannets (n= 4,069) recorded in boat-based surveys in the breeding season of April to September in both Project Alpha and Project Bravo.

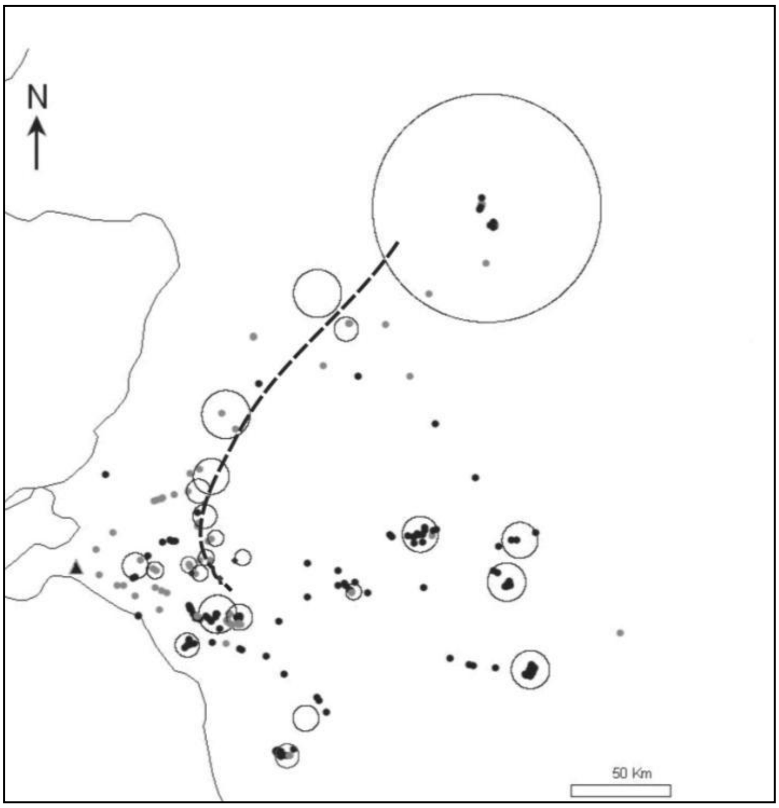


10.364. Such foraging trips could conceivably include Halibut Bank and Buchan Deep suggested to be important foraging areas for Gannets from Bass Rock by Camphuysen (2011), but in general appeared to match the area of Fladen Ground identified by Hamer *et al. (*2011) from data gathered in 2003 (Plot 10.37)

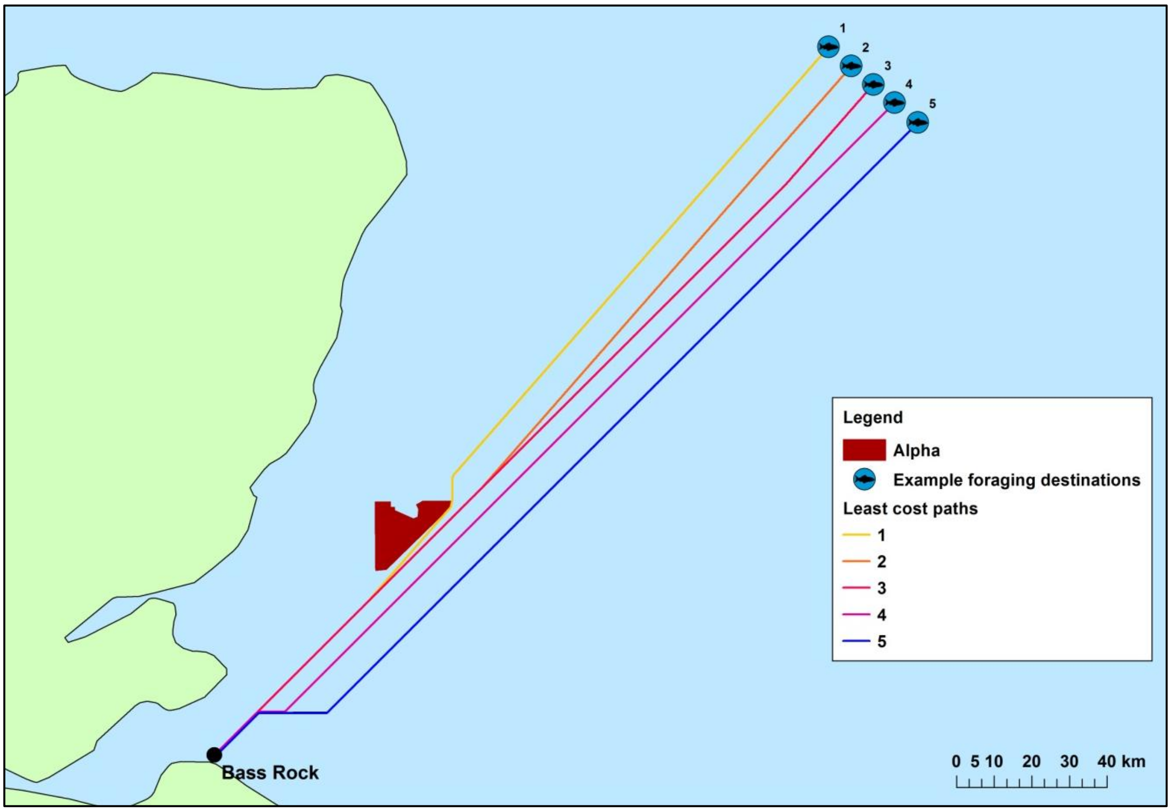
10.365. To account for the large area covered by the foraging area, a series of endpoints were established (Plot 10.38), with a mean distance (± 1SD) of 253.8km ± 2.4km i.e. a total foraging trip of 507.6km. Comparison of the distances travelled to reach the foraging area in the presence of Project Alpha assuming a least cost path was adopted estimated no increased distance, although one of the flight lines did cross Project Alpha suggesting some additional distance. Comparison with straight-line routes suggested a possible additional mean distance of 7.47 ± 3.8km.

10.366. No resultant daily energy expenditure was incurred from least cost path analysis, although straight-line paths suggested an increase of 2.3% daily energy expenditure from additional daily energy cost = (0.0003 x additional distance [m]) + 0.095 (Plot 10.35). In either case a negligible magnitude of effect was predicted, which with the high sensitivity of Gannet suggested an impact of minor significance.

Plot 10.37 Key foraging sites of chick-rearing gannets from Bass Rock in 2003 from Hamer *et al.* (2011). Open circles show positions of area-restricted search zones of foraging birds. Black and grey circles show locations of deep dives (≥ 2 m) and shallow dives (< 2 m) respectively.



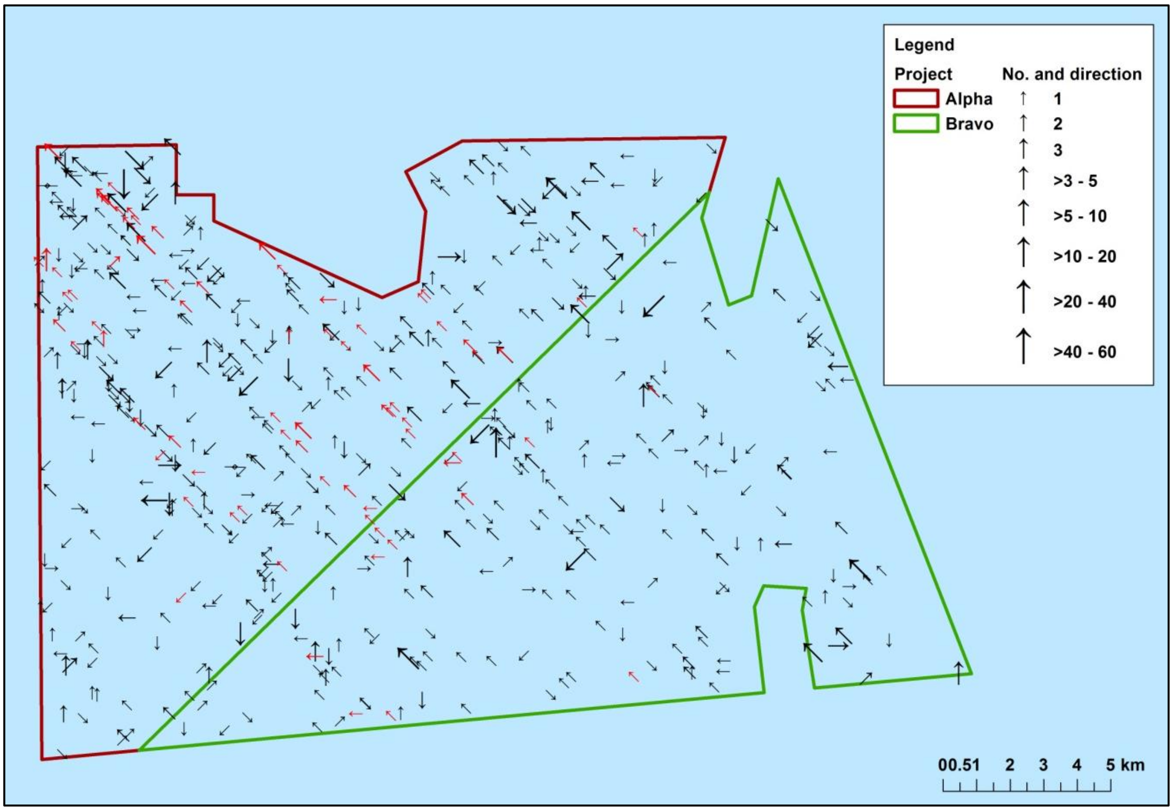
Plot 10.38 Predicted least cost path flight lines of Gannet from Bass Rock to Fladen Ground in the presence of Project Alpha.



10.367. Boat-based surveys showed the presence of all breeding auks – Guillemot, Razorbill and Puffin – within Project Alpha in the breeding season. For Guillemot, tracking studies suggested that the site fell outside the range of Guillemots from the Isle of May (Plot 10.29) and the Baseline Technical Report (Volume III Appendix F1) concluded that Guillemots in Project Alpha were most likely to originate from Fowlsheugh SPA, with some contribution from smaller colonies in Kincardine, Deeside and Angus. Trip duration studies suggested a range of up to 56km from Fowlsheugh.

10.368. The flight direction of birds in Project Alpha reinforces the link with Fowlsheugh, with a flight axis from southeast (from the colony) (15% of flights) but especially northwest (40% of flights) to the colony (Plot 10.39). The inequality of the frequency of the two directions suggests that the site and not some area beyond the site is the destination for birds. The declining frequency of birds carrying prey across Project Alpha and into Project Bravo further reinforces the view that Guillemot was unlikely to forage much beyond Project Alpha, especially since the estimated 56km maximum range falls at the southeastern corner of Project Bravo.

Plot 10.39 Flight directions of Guillemots (*n*= 1,009) recorded in boat-based surveys in the breeding season of April to September in both Project Alpha and Project Bravo.



10.369. The available evidence that Guillemot was likely to be nearing the edge of its range within Project Alpha and certainly within Project Bravo, coupled with the lack of a clear foraging endpoint that would be restricted by the sites, suggested that no barrier effect was likely to operate and that an assessment of displacement would capture any effects upon birds in Project Alpha.

10.370. Although two of the 110 foraging trips of Razorbills from the Isle of May encroached into Project Alpha, the site was not within core foraging range (Plot 10.30). As a result of the preponderance of northwesterly flights in Project Alpha (38%) the Baseline Technical Report (ES Volume III Appendix F1) concluded that most Razorbills were likely to originate from Fowlsheugh, the largest colony within mean maximum range. Again, the dominance of return rather than outbound flights (2%) suggested birds at the edge of their foraging range. Razorbill typically has a smaller foraging range than Guillemot and with no available evidence to the contrary a similar argument to that for Guillemot was adopted, in that no meaningful barrier effect was likely to operate. Any effect of the sites upon Razorbill would therefore be captured within the assessment of displacement (see 10.344 above).

10.371. Puffins recorded within Project Alpha in the breeding season most likely originated from the Isle of May given the fact that it supports 97.9% of the pool of birds from all colonies likely to interact with the Projects (the available evidence suggested that birds from the Farne Islands would not reach the sites). The predominance of the returning southwesterly direction of flight (37%) relative to the outward northeasterly flight (15%) again suggested birds were at the edge of range. Coupled with the lack of a clear target location, no meaningful principles of a barrier effect could be established and the assessment of displacement was assumed to incorporate any effect of that type of the operational site upon Puffin.

10.372. Overall, no meaningful barrier effect caused by Project Alpha was assumed to operate on any breeding auk species. The magnitude of any barrier effect, should any operate, is therefore considered to be negligible and therefore is minor and **not significant**.

10.373. Confidence in the assessment of barrier effects was relatively high on Gannet and Kittiwake as it was based on specific research studies (some of which were commissioned by FTOWDG) at the forefront of knowledge both on individual movements (see Daunt *et al.*, 2011a,b,c, Hamer *et al.*, 2011) and theoretical consideration of energetic constraints (Masden *et al.*, 2010) and supported by evidence from boat-based surveys.

10.374. Confidence in the assessment of barrier effects upon auks was lower as a result of a lack of specific studies either from relevant colonies (e.g. Razorbill at Fowlsheugh) and the limited dataset upon Puffins from the Isle of May (see Baseline Technical Report ES Volume III Appendix F1). However, partly as any displacement-type effect was also assessed within displacement itself, it was thought that additional data would be relatively unlikely to significantly change the conclusions reached.

Mitigation

Mitigation
At this stage no mitigation is proposed for collision risk.

10.375. As already explained within Chapter 5 Project Description and Chapter 6: EIA Process, retaining flexibility in the selection of preferred design options is a vital mitigation in the management of project risks and enables significant procurement commitments to be made at a more appropriate time later in the development process. As such, until final design options are determined, including WTG array layouts, the WTG specification and supplier, foundation type and installation methodology, and the electrical design, it is not possible to establish any mitigation for potential collision impacts.

10.376. Following detailed design, as with displacement, collision risk could potentially be mitigated by careful placement of WTGs reducing the impact of barrier effects. In this respect, a corridor between turbines could be created to allow an uninterrupted flight path to key foraging grounds for both Kittiwake and Gannet.

Residual Impact

10.377. Without specific location of the WTGs and thus the actual flight corridor created, the residual impact cannot be predicted. As the predicted distances and DEE resulted in a negligible impact, the overall significance would not be reduced unless no impact could be proven.

Mortality through collision with turbine blades

10.378. As collision is irreversible and final, the risk of mortality from collision with turbine blades is classed as a long term and permanent effect. Gannet, Kittiwake, Lesser Black-backed Gull, Herring Gull and Great Black-backed Gull have been considered for this potential impact. With the exception of Great Black-backed Gull (Medium sensitivity), all other species birds are of High sensitivity.

10.379. Morphological and behavioural parameters of the sensitive bird species required for CRM are shown in Table 10.28.

Table 10.28 Morphological and behavioural parameters of sensitive species used in the CRM taken from the general literature.

Species	Bird length (m) [1]	Wingspan (m) [1]	Flight speed (m/s) [2]	Night activity (%) [3]	Risk height (%) [4]	Adult birds (%)	
						Alpha	Bravo
Gannet	0.93	1.72	14.9 [5]	0 [6]	9.9	96.7	97.8
Kittiwake	0.39	1.07	13.1	50	9.2	94.1	95.8
Lesser Black-backed Gull	0.59	1.45	13.1	50	19.3	89.5	68.8
Herring Gull	0.61	1.44	12.8	50	19.8	63.6	77.8
Great Black-backed Gull	0.71	1.58	13.7	50	23.9	55.6	54.5

1. BWPi (2004). 2. Alerstam *et al.* (2007). 3. Garthe and Hüppop (2004). 4. The proportion at 26m (the minimum blade clearance of the worst case scenario at Alpha and Bravo) and above using statistically-generated generic data from SOSS (Cook *et al.*, 2011). 5. Pennycuick (1997). 6. Hamer *et al.* (2011).

10.380. Collision rates were calculated for each species based on observations during boat-based surveys and are presented at a range of avoidance rates, including no avoidance (see Table 10.29). For the purpose of consistency within this impact assessment, a standard avoidance rate of 98% has been considered following guidance from the SNCBs. However, it is expected that in practice, avoidance rate will invariably be higher.

Table 10.29 Predicted annual number of collisions at Project Alpha of each sensitive species specified as all individuals, at different rates of avoidance (0-99.5%), using data from boat-based surveys under the worst case scenario of 75 x 7 MW.

Species	Avoidance rate				
	0	95	98	99	99.5
Gannet	50,224	2,511	1,004	502	251
Kittiwake	33,741	1,687	675	337	169
Lesser Black-backed Gull	665	33	13	7	3
Herring Gull	3,819	191	76	38	19
Great Black-backed Gull	7,306	365	146	73	37

10.381. Where there are specific populations of importance for nature conservation, particularly SPA breeding colonies within foraging range of the Project Alpha site, the total collision rate was partitioned so that the impact on those specific populations could be assessed. This partitioning was achieved by calculating the collision rate only for that proportion of birds that were assumed to be associated with the breeding colony, i.e. adults recorded during the breeding season for species that can be aged (Table 10.30).

10.382. The predicted collision rate for Gannet at Project Alpha is 1,004 birds per annum, with 904 predicted during the breeding season alone (Table 10.28). In the context of a population of the UK of 655,638 individuals this level of mortality is considered to be of low magnitude (see Table 10.8). Combined with the high sensitivity classification for Gannet, mortality through collision with turbine blades on the national breeding population predicts an impact of moderate which is considered to be **significant**.

10.383. However, the predicted collision rate for the Gannet population from designated colonies (SPAs and SSSIs) was 875 adult birds (904 individuals of all ages) per annum. Using the breeding population of 116,538 individuals within mean maximum foraging range of 229.4km, the loss per annum is equivalent to 0.75% of the population. An effect of *medium* magnitude is therefore predicted resulting in an impact of *major* significance. An effect upon the population of 153,022 individuals within mean maximum (+1 SD) is also of *medium* magnitude (0.57% affected) and thus an impact of *major* and *significant* is maintained.

10.384. Modelling predicts 675 collisions per annum at Project Alpha for Kittiwake, with 201 birds predicted during the breeding season (Table 10.28). Predicted mortality equates to 0.06% in the context of the population of the UK (1,139,676) and is therefore of negligible magnitude. In combination with the high sensitivity of Kittiwake, a minor and **significant** impact is predicted.

10.385. The predicted mortality for the Kittiwake population at designated colonies within foraging range was 113 adult birds (120 individuals of all ages) per annum in relation to the population of 38,840 individuals. Within mean maximum foraging range (+1SD) mortality of 134 adult birds (142 individuals of all ages) with designated colonies was predicted. The proportion of each population affected implies an impact of low magnitude of effect (0.17 to 0.5%) for both populations. The significance of the impact is therefore predicted to be *moderate* and *significant*.

10.386. The predicted collision rate at Project Alpha for Lesser Black-backed Gull was 13 individuals per annum or 7 for the breeding season (Table 10.30). In the context of the UK population (breeding birds multiplied by 1.5 to account for all birds) the magnitude of the impact is considered to be negligible, with a resulting minor and **not significant** impact. The predicted collision rate for the population within designated colonies (i.e. the Forth Islands SPA) was two birds (Table 10.30). Again the magnitude of the effect on this population is considered negligible and thus is *minor* and *not significant*.

10.387. Modelling predicts 76 collisions per annum at Project Alpha for Herring Gull, with 25 birds predicted during the breeding season (Table 10.30). When considered in the context of all collisions throughout the year, this potential effect is of negligible magnitude. In combination with the high sensitivity of Herring Gull, a minor and **not significant** impact is predicted.

Table 10.30 Predicted annual number of collisions of sensitive species at Project Alpha at an avoidance rate of 98%. Results are specified as individuals for the whole year, all individuals during the breeding season, and individuals within designated colonies and at specific component populations, including using the proportion of adults observed in surveys in parentheses.

Species	Component population	Number of individuals	Predicted collisions per annum [1]	Proportion (%) [1]
Gannet	All	655,638 [2]	1,004	0.15
	Breeding season	437,092 [3]	904	0.21
	Designated colonies within mean max foraging range [4]	116,538 [5]	904 (875)	0.78 (0.75)
	Designated colonies within mean max foraging range +1SD [6]	151,822 [5]	897 (868)	0.59 (0.57)
	Forth Islands SPA	110,964 [5]	861 (833)	0.78 (0.75)
Kittiwake	All	1,139,676 [2]	675	0.06
	Breeding season	759,784 [3]	201	0.03
	Designated colonies within mean max foraging range [4]	38,840 [5]	120 (113)	0.31 (0.29)
	Designated colonies within mean max foraging range +1SD [6]	88,204 [5]	142 (134)	0.16 (0.15)
	Forth Islands SPA	5,370 [7]	17 (16)	0.32 (0.30)
	Fowlsheugh SPA	28,386 [5]	88 (83)	0.31 (0.28)
Lesser Black-backed Gull	All	336,222 [2] (120,000 [8])	13	<0.01 (0.01)
	Breeding season	224,148 [3]	7	<0.01
	Designated colonies within mean max foraging range [4,9]	6,916 [5]	2 (2)	0.03 (0.03)
	Forth Islands SPA	6,914 [5]	2 (2)	0.03 (0.03)
Herring Gull	All	417,927 [2] (730,000 [8])	76	0.02 (0.01)
	Breeding season	278,618 [3]	25	0.01
	Designated colonies within mean max foraging range [4]	6,850 [5]	8 (5)	0.12 (0.07)
	Designated colonies within mean max foraging range +1SD [6]	18,196 [5]	10 (6)	0.05 (0.03)
	Forth Islands SPA	6,422 [7]	7 (5)	0.11 (0.08)
	Fowlsheugh SPA	428 [5]	0.5 (0.3)	0.12 (0.07)
Great Black-backed Gull	All	51,480 [2] (76,000 [8])	146	0.28 (0.19)
	Breeding season	34,320 [3]	5	0.01
	Designated colonies within mean max foraging range [10]	56 [5]	0.9 (0.5)	1.61 (0.89)

1. For designated populations, and where data is available, values in parentheses refer to adult birds only. 2. Breeding population of UK from Baker *et al.* (2006) x 1.5 to estimate for non-breeding birds. 3. Breeding population of UK from Baker *et al.* (2006). 4. All SPA and SSSI designated colonies within mean maximum foraging range. 5. Latest breeding population as specified in Baseline Technical Report (Volume III Appendix F1). 6. All SPA and SSSI designated colonies within mean maximum foraging range +1SD. 7. Latest breeding population within mean maximum foraging range from as specified in Baseline Technical Report (Volume III Appendix F1). 8. Wintering population from Musgrove *et al.* (2011). 9. There are no additional designated colonies between mean maximum and mean maximum +1SD foraging ranges. 10. SSSI designated colonies within mean maximum foraging range. There are no SPA designated colonies within this range.

10.388. The predicted mortality of the Herring Gull in relation to designated colonies within mean maximum foraging range was 8 individuals of all ages per annum (10 birds including 1 SD) equivalent to 0.12% of the population (Table 10.30). This equates to an impact of low magnitude and the resultant significance of the impact is predicted to be *moderate* and *significant*.

10.389. The predicted collision rate for Great Black-backed Gull at Project Alpha is 146 birds per annum, but with only 5 birds predicted during the breeding season (Table 10.30). In the context of a breeding population of the UK of 34,320 individuals this level of annual mortality is considered to be of negligible magnitude, resulting in a minor and **not significant** impact.

10.390. CRM has been rigorously tested and therefore the confidence in it as an assessment tool is high. However, the predicted mortality is heavily influenced by the avoidance rate, with this likely to be far higher (99% or more) than the precautionary rate used (98%). A more appropriate avoidance rate would reduce predicted mortality by at least 50%. Studies to determine the specific avoidance rate of individual seabird species are urgently required, which would allow greater confidence in the impact of mortality through collision with turbine blades.

Mitigation

Mitigation
At this stage no mitigation is proposed for collision risk.

10.391. As already stated in section 10.375, at this stage it is not possible to confirm mitigation for collision risk. However, following detailed design, it may be possible to avoid collision hotspots. By adapting the Band Model (Band, 2011), using average collision risk factor, an index of collision was created for each individual snapshot during the breeding season. Using this technique, collision hotspots may be identified (see Plots 10.43 & 10.44 below). Avoidance of these areas could reduce the potential impact of mortality through collision with turbines.

Residual Impact

10.392. Further analysis would be required to assess the residual impact, as the actual location of the turbines would be required in any calculation of spatial collision risk.

Project Bravo

Displacement

10.393. The same four sensitive receptors were considered for long-term potential impact of displacement from Project Bravo as Project Alpha. These were Kittiwake, Guillemot, Razorbill and Puffin. Based on the same avoidance distances expressed for Project Alpha (300m for Kittiwake and 400m for the auks), Kittiwake would be displaced from 10% of the Project Bravo site and the auks 17%. The population matrix (Table 10.14) was adjusted accordingly.

10.394. The peak population estimate during the breeding season for Kittiwake was 2,814 individuals (June 2011 – Plot 10.10). Displacement from 17% of the site resulting in 100% mortality would affect 0.03% of the national population of 1,139,676 Kittiwake (the breeding population multiplied by 1.5 to include non-breeding birds). Whilst a mortality rate of 100% is clearly unrealistic, this would still be considered to generate a negligible magnitude of effect. A mortality rate of 1% would affect 0.0002% of the national population and is thus displacement of Kittiwake from Project Bravo is considered to be negligible and **not significant**. Using the matrix to predict the impact on designated colonies from which the foraging range of Kittiwake (mean maximum – Thaxter *et al.*, 2012) would reach Project Bravo, a mortality rate of 1% from 10% displacement would affect 0.007% of the population (38,840 individuals), which is also predicted to be *negligible* and *not significant*.

10.395. The relative loss of foraging grounds to the development of Project Bravo, nor indeed its importance to Kittiwake have not been factored into the magnitude of the potential impact on Kittiwake. However, as described for Project Alpha, the entire Project Bravo footprint (i.e. not taking into account the usable area between turbines) equated to ~3% of the foraging ranges of each Fowlsheugh, Forth Islands and St. Abb's Head to Fast Castle SPAs. Such a loss would be of low magnitude (Table 10.9).

10.396. Tracking studies from both Fowlsheugh (Plot 10.31) and the Isle of May (Plot 10.32) provided evidence that although Project Bravo was within foraging range of both colonies, it was not within core foraging habitat. Thus, even if this sub-optimal habitat were lost, this would not be likely to affect breeding performance. The use of the concept of habitat quality lends further weight to the assessment of displacement as of negligible effect with a resultant impact of minor and **not significant**.

10.397. The peak estimate for Guillemot was also recorded in June 2011, with an estimated 10,569 birds present within the Project Bravo site boundary (Plot 10.15). Using this population in the matrix (Table 10.14), total displacement (100%) resulting in 100% mortality would affect 0.5% of the national population (2,131,350 individuals – breeding population multiplied by 1.5) and thus be of medium magnitude. Using a more realistic displacement value of 17% (see above), a mortality rate of 1% would affect 0.001% of the national population and thus be an effect of negligible magnitude. Based on the mean maximum foraging range of Guillemot, displacement from 17% of the Project Bravo footprint resulting in 1% mortality would impact on 0.01% of the population of 130,810 individuals from designated colonies and again be of negligible magnitude giving a *minor* and *not significant* impact.

10.398. In contrast to the other sensitive receptors, the peak breeding population for Razorbill was recorded in July 2011, with an estimated 583 individuals (Plot 10.17). In relation to the national population of 282,864 individuals (estimate from Baker *et al.*, 2006 x 1.5) displacement from 17% of the Project Bravo footprint resulting in 1% mortality would affect 0.0004% of the population and therefore be of negligible magnitude. The unrealistic scenario of 100% displacement resulting in 100% mortality would affect 0.21% of the population with a low magnitude of impact. Using the population of Razorbill in designated colonies within foraging distance (4,632 individuals), 1% mortality from 17% displacement would impact on 0.01% of the population and thus also be considered of negligible magnitude and giving an impact of *minor* and *not significant*.

10.399. The June 2011 survey estimated a peak population of 5,439 Puffin (Plot 10.20). Based on 17% displacement and 100% mortality 0.05% of the national population would be affected. A scenario of 1% mortality would affect 0.0005% of the national population implying an effect of negligible magnitude. Using a population derived from designated colonies capable of foraging within Project Bravo (using mean maximum foraging range from Thaxter *et al.*, 2012), 0.03% of the population would be affected from 17% displacement and 1% mortality, equivalent to a negligible effect and an impact of *minor* and *not significant*.

10.400. The assessments of the magnitude of effect are further supported by consideration of the total foraging ground lost due to the development according to the area of the site relative to the total foraging area available to the species at each colony suggested by mean maximum foraging range. Calculations show the proportion to be 1.6% and 1.9% for Guillemot from Fowlsheugh and the Isle of May respectively, 4.75 and 4.3% for Razorbill from Fowlsheugh and the Isle of May respectively, and 1.3% for Puffin from the Isle of May. All of these represent values of a low magnitude of effect (Table 10.9).

10.401. Tracking studies also suggest that core foraging grounds of all breeding auks from the Isle of May do not fall within the Project Bravo boundary (see Plots 10.30 & 10.31 for Guillemot and Razorbill). Trip duration studies of Guillemot from Fowlsheugh suggest that most foraging occurs relatively close to the colony (Daunt *et al.*, 2011b). A similar trend may be expected for the shorter-ranging Razorbill. These observations tend to support the overall assessment of an effect of displacement of negligible magnitude on all breeding auks resulting in a minor and **not significant** impact.

10.402. Confidence in the assessment of displacement from Project Bravo is as described for Project Alpha (see 10.355 above).

Mitigation

Mitigation
At this stage no mitigation is proposed.

10.403. The mitigation described for Project Alpha (see 10.356) is also applicable to Project Bravo. In summary, following detailed design, it may be possible to avoid any areas of value as foraging habitat to sensitive receptors which may reduce displacement impacts further.

Residual Impact

10.404. The residual impact following mitigation for the impact of displacement would be as described for Project Alpha. In essence, avoidance of any areas of foraging habitat that may conceivably be used by sensitive receptors, especially those originating from Fowlsheugh SPA, could effectively result in displacement with negligible and **not significant** impact.

Barrier effects

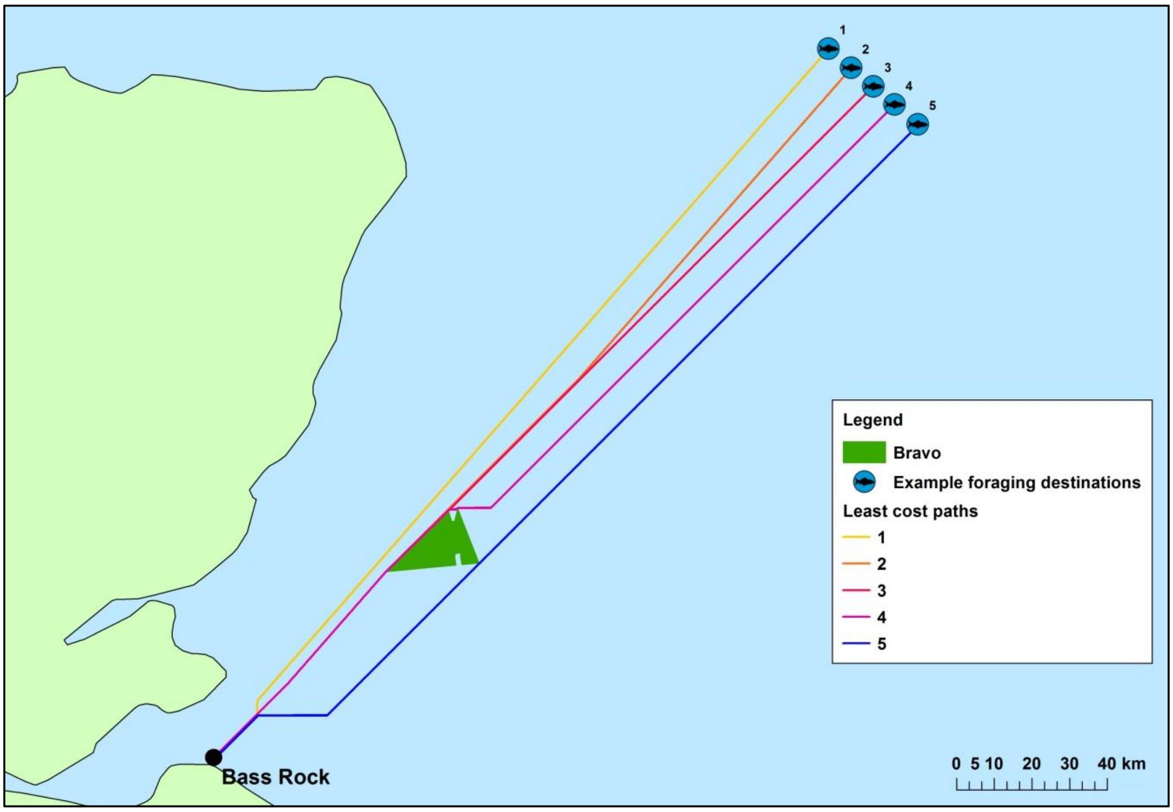
10.405. The same five sensitive receptors at Project Alpha, Gannet, Kittiwake, Guillemot, Razorbill and Puffin were considered for the potential impact of barrier effects at Project Bravo.

10.406. As with Project Alpha, barrier effects on Kittiwake are only considered for those birds from the Isle of May ranging to the core foraging patch at the northeastern extremity of Projects Alpha and Bravo (Plots 10.31 & 10.32). The analysis of least cost path showed there was no increase in distance of the foraging trip of 168.8km from the Isle of May to the foraging patch and back (Plot 10.34).

10.407. With no increase in daily energy expenditure the effect was of negligible magnitude (see Table 10.16). The overall impact of barrier effects of Project Bravo on Kittiwake is thus predicted to be minor and **not significant**.

10.408. The increase in distance travelled by Gannet to reach the foraging area in the presence of Project Bravo in isolation assuming a least cost path was 1.01 ± 1.87km (Plot 10.40). From the relationship extrapolated from that shown by Masden *et al.* (2010) where additional daily energy cost = (0.0003 x additional distance [m]) + 0.095 (Plot 10.35), the resultant additional daily energy expenditure was 3.0%. Such an effect is of negligible magnitude, which combined with the high sensitivity of Gannet gives an impact of minor and **not significant**.

Plot 10.40 Predicted least cost path flight lines of Gannet from Bass Rock to Fladen Ground in the presence of Project Bravo.



10.409. As described at Project Alpha, a negligible magnitude and overall minor and **not significant** impact is suggested for Guillemot, Razorbill and Puffin, as the evidence suggests that barrier effects are not in operation for these species

Mitigation

Mitigation
At this stage no mitigation is proposed.

10.410. As with Project Alpha (see 10.375 – 10.376), following detailed design it may be possible to establish a flight corridor between turbines to allow uninterrupted movement of birds attempting to access distant foraging grounds which could mitigate any barrier effects.

Residual Impact

10.411. Details of a flight corridor relative to the location of WTGs would be required to analyse any residual impact. As with Project Alpha, the predicted additional distances and additional energy expenditure of all species assessed resulted in a negligible impact. The overall significance could therefore not be reduced unless no impact could be proven.

Mortality through collision with turbine blades

10.412. The same five species have been considered for the potential impact of collision with turbine blades for Project Bravo as Project Alpha. The predicted mortality based on various avoidance rates (including 0%) is shown in Table 10.31. The impact on national populations and specific SPAs for which species are designated are shown at a ‘standard’ avoidance rate of 98% in Table 10.32.

Table 10.31 Predicted annual number of collisions at Project Bravo of each sensitive species specified as all individuals at different rates of avoidance (0-99.5%), using data from boat-based surveys under the worst case scenario of 75 x 7 MW.

Species	Avoidance rate				
	0	95	98	99	99.5
Gannet	33,053	1,653	661	331	165
Kittiwake	31,210	1,560	624	312	156
Lesser Black-backed Gull	1,440	72	29	14	7
Herring Gull	2,388	119	48	24	12
Great Black-backed Gull	6,053	303	121	61	30

10.413. At an avoidance rate of 98%, the predicted collision rate for Gannet at Project Bravo is 661 birds per annum, with 552 birds predicted during the breeding season alone (Table 10.32). Such mortality equates to 0.10% in the context of the all birds in the UK (655,638 individuals), which is considered to be a low magnitude of effect. Combined with the high sensitivity of Gannet, a moderate and **significant** impact of mortality through collision with turbine blades on the national breeding population is predicted.

10.414. The predicted mortality for the Gannet population within designated populations within mean maximum foraging range was 540 adult birds (or 535 individuals within mean maximum range including +1SD) per annum (Table 10.32). At either scale, a low magnitude is suggested resulting in a moderate and **significant** impact.

10.415. Modelling predicts 624 collisions per annum at Project Bravo for Kittiwake, with 263 predicted during the breeding season (Table 10.32). In either context, the potential effect is of negligible magnitude. In combination with the high sensitivity of Kittiwake, a minor and **not significant** impact is predicted.

10.416. A total of 151 adult Kittiwakes (157 individuals of all ages) from designated colonies within mean maximum foraging range were predicted to collide per annum. Extending the range to include 1 SD resulted in collision of 178 adult birds (186 individuals of all ages) per annum (Table 10.32). Both rates of collision imply an effect of *low* magnitude. Therefore, the significance of any impact at this scale is predicted to be *moderate* and *significant*.

10.417. The predicted collision rate for Lesser Black-backed Gull at Project Bravo was 29 individuals per annum or 27 for the breeding season (Table 10.32). In the context of the UK population of 336,222 individuals (breeding population x 1.5) the magnitude of the effect is considered to be negligible, with a resulting minor and **not significant** impact. The predicted collision rate for designated colonies was 5 adults (8 individuals of all ages) (Table 10.32). The magnitude of the effect on this adult population is also considered to be negligible and thus *minor* and *not significant*.

10.418. Modelling predicts 48 collisions of Herring Gull per annum at Project Bravo (Table 10.32). When considered in the context of the UK population of 417,297 individuals this potential effect is of negligible magnitude giving a minor and **not significant** impact.

10.419. The predicted collision rate for the Herring Gull population at designated colonies within foraging range was 4 adult birds (5 individuals of all ages) per annum (Table 10.32), resulting in an effect of negligible magnitude. The significance of the impact of mortality from collision with turbine blades on designated colonies is therefore predicted to be *minor* and *not significant*.

10.420. The predicted collision rate for Great Black-backed Gull at Project Bravo is 121 birds per annum, but with only 17 birds predicted during the breeding season (Table 10.32). In the context of a UK population of 51,480 individuals this level of annual mortality is considered to be of low magnitude, resulting in the impact of collision with turbine blades of minor and **not significant**.

10.421. As with the CRM described for Project Alpha, confidence in the output of assessment (and not the method *per se*) would be greater with specific avoidance rates for individuals species based on dedicated studies.

Mitigation

Mitigation

At this stage no mitigation is proposed.

10.422. Mitigation measures described for Project Alpha (see 10.391) for the potential impact of mortality through collision with turbines is applicable to Project Bravo. In summary, following detailed design, it may be possible to avoid areas supporting higher densities of birds which could reduce the potential impact of mortality through collision with turbines.

Residual Impact

10.423. The residual impact of any mitigation measures adopted for Project Bravo would be as described at Project Alpha above.

Table 10.32 Predicted annual number of collisions of sensitive species at Project Bravo at an avoidance rate of 98%. Results are specified as individuals for the whole year, all individuals during the breeding season, and individuals within designated colonies and at specific component populations, including using the proportion of adults observed in surveys.

Species	Component population	Number of individuals	Predicted collisions per annum [1]	Proportion (%) [1]
Gannet	All	655,638 [2]	661	0.10
	Breeding season	437,092 [3]	552	0.13
	Designated colonies within mean max foraging range [4]	116,538 [5]	552 (540)	0.47 (0.46)
	Designated colonies within mean max foraging range +1SD [6]	151,822 [5]	547 (535)	0.36 (0.35)
	Forth Islands SPA	110,964 [5]	525 (514)	0.47 (0.46)
Kittiwake	All	1,139,676 [2]	624	0.05
	Breeding season	759,784 [3]	263	0.03
	Designated colonies within mean max foraging range [4]	38,840 [5]	157 (151)	0.40 (0.39)
	Designated colonies within mean max foraging range +1SD [6]	88,204 [5]	186 (178)	0.21 (0.20)
	Forth Islands SPA	5,370 [7]	22 (21)	0.41 (0.39)
	Fowlsheugh SPA	28,386 [5]	115 (110)	0.41 (0.39)
Lesser Black-backed Gull	All	336,222 [2] (120,000 [8])	29	0.01 (0.02)
	Breeding season	224,148 [3]	27	0.01
	Designated colonies within mean max foraging range [4,9]	6,916 [5]	8 (5)	0.12 (0.07)
	Forth Islands SPA	6,914 [5]	8 (5)	0.12 (0.07)
Herring Gull	All	417,927 [2] (730,000 [8])	48	0.01 (0.01)
	Breeding season	278,618 [3]	16	0.01
	Designated colonies within mean max foraging range [4]	6,850 [5]	5 (4)	0.07 (0.06)
	Designated colonies within mean max foraging range +1SD [6]	18,196 [5]	6 (5)	0.03 (0.03)
	Forth Islands SPA	6,422 [7]	5 (4)	0.08 (0.06)
	Fowlsheugh SPA	428 [5]	0.3 (0.2)	0.07 (0.05)
Great Black-backed Gull	All	51,480 [2] (76,000 [8])	121	0.24 (0.16)
	Breeding season	34,320 [3]	17	0.05
	Designated colonies within mean max foraging range [10]	56 [5]	3 (2)	5.36 (3.57)

1. For designated populations, and where data is available, values in parentheses refer to adult birds only. 2. Breeding population of UK from Baker *et al.* (2006) x 1.5 to estimate for non-breeding birds. 3. Breeding population of UK from Baker *et al.* (2006). 4. All SPA and SSSI designated colonies within mean maximum foraging range. 5. Latest breeding population as specified in Baseline Technical Report (Volume III Appendix F1). 6. All SPA and SSSI designated colonies within mean maximum foraging range +1SD. 7. Latest breeding population within mean maximum foraging range from as specified in Baseline Technical Report (Volume III Appendix F1). 8. Wintering population from Musgrove *et al.* (2011). 9. There are no additional designated colonies between mean maximum and mean maximum +1SD foraging ranges. 10. SSSI designated colonies within mean maximum foraging range. There are no SPA designated colonies within this range.

Transmission Asset Project

Infrastructure within the Project Alpha and Project Bravo site boundaries

Disturbance due to maintenance activity

10.424. Disturbance of birds resulting from maintenance vessel activity around the OSPs is likely to be similar in scope to that discussed in relation to the construction phase (Table 10.27), with no species subject to potentially significant impacts (Table 10.33). Whilst associated maintenance and vessel activity will be permanent (for the lifetime of the wind farm), it will be at significantly lower in intensity than during construction, and as such impacts are not likely to be significant and do not require further assessment.

Avoidance and displacement from the wind farm site

10.425. Avoidance and displacement due to OSPs in the operational wind farm is expected to be negligible when compared to potential effects from operational turbines. The OSPs will be subsumed within the wind farm layout and are significantly smaller in height than individual turbines. Impacts are therefore considered unlikely to be significant and no further assessment is required.

Indirect effects

10.426. It is concluded that no indirect effects on habitat or prey species will result from operational OSPs and as such, impacts are considered to be negligible and **not significant** and no further assessment is required.

Export Cable Route (ECR) Corridor

10.427. Operation of the export cable is considered benign in terms of impacts on ornithological receptors. Maintenance of the export cable is likely to be infrequent, localised and temporary. Surface vessels will be used for any operation and maintenance activity, and therefore habitat disturbance associated with jack-up vessels is considered to be unlikely. Potential impacts on ornithological receptors associated with operation and maintenance of the export cable are not considered likely to be prolonged or significant, and no further assessment is deemed to be required.

Summary of the effects of the operational phase

10.428. Table 10.33 provides a summary of the significance of all effects during the operational phase of the Transmission Asset Project.

Table 10.33 Summary of the significance of all effects in the operational phase of the Transmission Asset Project.

Species	Sensitivity	OSPs			ECR corridor
		Disturbance (maintenance)	Disturbance/ displacement	Indirect effects	
Gannet	High	Minor	Minor	Minor	Minor
Kittiwake	High	Minor	Minor	Minor	Minor
Great black-backed gull	Low	Negligible	Negligible	Negligible	Negligible
Guillemot	High	Minor	Minor	Minor	Minor
Razorbill	Medium	Negligible	Negligible	Negligible	Negligible
Puffin	High	Minor	Minor	Minor	Minor

IMPACT ASSESSMENT – DECOMMISSIONING

Project Alpha

Displacement through disturbance due to increased boat traffic

10.429. The potential impact of displacement through disturbance due to increased boat traffic during the decommissioning phase for Project Alpha is considered the same as during the construction phase of the project.

Indirect effects of decommissioning on prey

10.430. Chapter 12: Natural Fish and Shellfish Resource predict an impact of minor significance for disturbance due to noise during decommissioning. Classifying the magnitude of indirect effects of decommissioning on prey on the ornithology as negligible, results in an impact of minor significance for Kittiwake, Guillemot, Razorbill and Puffin (high sensitivity), and negligible for Arctic Tern (medium sensitivity).

Project Bravo

Displacement through disturbance due to increased boat traffic

10.431. The impact of displacement through disturbance due to increased boat traffic during the decommissioning phase for Project Bravo is considered the same as Project Alpha.

Indirect effects of decommissioning on prey

10.432. The potential impact of indirect effects of construction during the decommissioning phase for Project Bravo is considered the same as Project Alpha.

Transmission Asset Project

10.433. The potential effects on ornithology during the decommissioning phase are considered to be similar in magnitude and duration to those that might be expected during the construction phase. Therefore, it is considered that the effects of decommissioning are accounted for in paragraphs 10.286 to 10.338, and summarised in Table 10.27.

IMPACT ASSESSMENT – CUMULATIVE AND IN-COMBINATION

The Seagreen Project Cumulative Impacts

10.434. The Seagreen Project combines Project Alpha and Project Bravo with the Transmission Asset Project. All seven potential impacts of Project Alpha and Project Bravo have been considered cumulatively in this section. Due to the nature of the Transmission Asset, it has only been considered cumulatively within this section of the ES chapter in the construction and decommissioning stages of the Seagreen Project. Table 10.34 provides information on the impacts assessed for Project Alpha and Project Bravo and the Transmission Asset Project and a cumulative impact of the Seagreen Project.

Displacement through disturbance due to increased boat traffic during construction

10.435. The cumulative impact of disturbance from increased boat traffic is unlikely to increase in magnitude from either Project Alpha or Project Bravo alone. Therefore the magnitude of effect of disturbance on the nine sensitive receptors is considered to be negligible. For the species with a high sensitivity classification, Gannet, Kittiwake, Lesser Black-backed Gull, Herring Gull, Guillemot, Razorbill and Puffin the predicted impact is minor and **not significant**. For Great Black-backed Gull and Arctic Tern (medium sensitivity) the overall significance of the impact is predicted to be negligible and **not significant**.

Indirect effects on prey during construction

10.436. The cumulative impact of indirect effects on prey through construction is considered to be effectively the same as that described for the individual projects, according to the impact range upon sensitive clupeids shown in Plot 10.5. This is partly because the worst case scenario of simultaneous piling at Project Alpha and Project Bravo at the extreme of each site (i.e. the western boundary at Project Alpha and the eastern boundary of Project Bravo) cannot displace Herring / Sprat further to the north or south. The impact upon the key foraging grounds of Marr Bank and Wee Bankie for many species thus remains the same. Moreover, the area of Scalp Bank immediately to the east of Project Alpha in particular is also affected by all piling at any WTG location in either site.

10.437. Therefore, a predicted low magnitude results in a moderate and **significant** impact for high sensitivity breeding Guillemot, Razorbill and Puffin, while a negligible magnitude for the sandeel-dependent breeding Kittiwake suggests impacts of minor and **not significant**. For Arctic Tern on passage, a low magnitude combined with medium sensitivity results in a predicted impact of minor and **not significant**.

Displacement

10.438. To assess the impact of displacement from the Seagreen Project on Kittiwake, Guillemot, Razorbill and Puffin, a precautionary approach of combining peak populations from each site regardless of whether they were recorded in the same month was adopted. Using the avoidance distances from turbines described in the Project Alpha and Project Bravo sections, the area that Kittiwake and the auk species were displaced from was 10.3% and 17.7% respectively.

10.439. The peak population of Kittiwake within the Seagreen Project was calculated to be 7,323 individuals. Using the matrix (Table 10.14), displacement from 10.3% of the Seagreen Project footprint that resulted in 1% mortality, would affect 0.001% of the national population of 1,139,676 (759,784 multiplied by 1.5 to incorporate non-adult birds). At this scale the magnitude of effect is negligible and the impact of displacement from the Seagreen Project is considered to be minor and **not significant**. In relation to the breeding population at designated colonies (calculated to be 4,511 ind.), 0.01% of the 38,840 individuals would be affected by 1% mortality, which is of negligible magnitude resulting in a *minor*, *not significant* impact.

10.440. Guillemot was estimated as having a peak population of 21,380 individuals within the Seagreen Project. Based on this population being excluded from 17.7% of the site footprint resulting in 1% mortality, 0.002% of the national population would be affected. This implies a negligible magnitude and an impact of minor and **not significant**. For the population of 130,810 individuals at designated colonies within foraging distance, 0.02% of the population would be affected by displacement under the conditions specified again resulting in a negligible magnitude suggesting a *minor* and *not significant* impact.

10.441. The estimated peak population for Razorbill within the Seagreen Project was 2,685 individuals. Based on 17.7% displacement from the Seagreen Project footprint resulting in 1% mortality, 0.002% of the national population would be affected. As such magnitude is considered to be negligible suggesting a minor and **not significant** impact. With respect to the population of 4,632 individuals within designated breeding colonies in foraging range, 0.07% of this population would be subject to a negligible magnitude of effect with a resultant impact of *minor* and *not significant*.

10.442. The overall peak population for Puffin within the Seagreen Project was estimated at 8,226 individuals. With a displacement from 17.7% of the footprint resulting in 1% mortality, 0.0008% of the national population would be affected by the development and therefore of a negligible magnitude of effect resulting in an impact of minor and **not significant**. In relation to the 199,007 individuals in designated colonies in foraging range, 0.05% of the population would be affected again suggesting a negligible magnitude of effect resulting in an impact of *minor* and *not significant*.

10.443. The evidence derived from the tracking studies from key colonies supporting the assessment of displacement for Project Alpha and Project Bravo in isolation is also applicable for the Seagreen Project. Whilst the area of potential habitat lost is increased, the quality of this habitat falling outside of core foraging habitat for all species at all colonies must be considered to be low for birds in the breeding season. As a result its loss is unlikely to have a detectable effect upon breeding performance of any species.

Mitigation

Mitigation
At this stage no mitigation is assumed.

10.444. Mitigation measures described in Project Alpha and Project Bravo (see 10.356) are applicable to the Seagreen Project. To summarise, any impacts may be reduced even further by avoidance of any areas that may be of value as foraging habitat to sensitive receptors in some years. The project envelope would appear to offer sufficient scope for this to be readily achieved, however, until detailed design requirements are understood it is not possible to establish mitigation.

Residual Impact

10.445. Avoidance of any areas of foraging habitat that may conceivably be used by the sensitive receptors originating from Fowlsheugh SPA and Forth Islands SPA could effectively result in displacement with negligible and **not significant** impact.

Barrier effect

10.446. No barrier effect could be demonstrated for any breeding auk species at either Project Alpha or Project Bravo alone, mainly as there was no evidence that any species crossed either or both sites to reach a particular destination. In all cases, it appeared that both sites and especially Project Bravo lay at the extreme of typical foraging range from breeding species. The barrier effect of the Seagreen Project was therefore only considered for Kittiwake and Gannet.

10.447. The effect upon the potential flight lines of Kittiwake from the Isle of May attempting to reach the foraging patch at the northeastern corner of the Seagreen Project is shown in Plot 10.41. The additional travel distance of 20.5km represents a 12.2% increase of the length of each foraging trip to this destination.

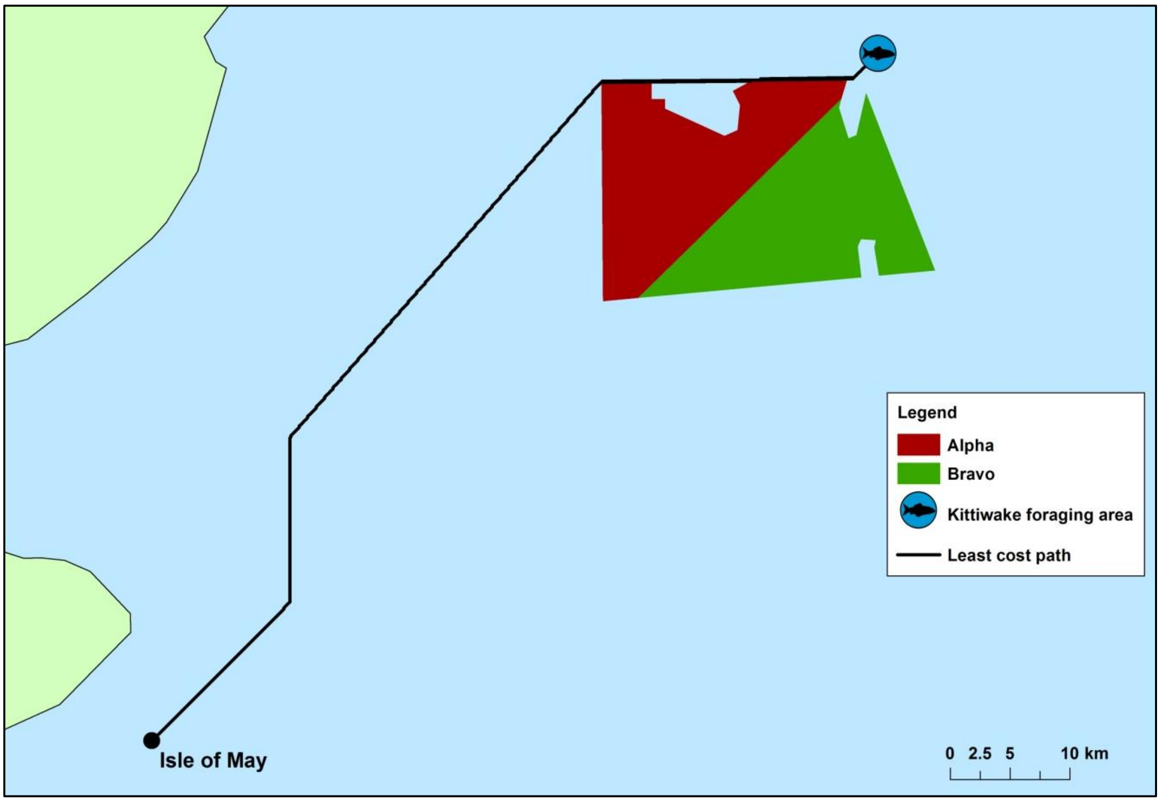
10.448. According to the relationship extrapolated from Masden *et al. (*2010) where additional energy cost = (0.0015 x additional distance [m]) - 0.08 (Plot 10.35) the additional daily energy expenditure of such a trip would be 30.7% and thus of low magnitude (see Table 10.16). The overall impact of barrier effects of the Seagreen Project on Kittiwake is thus predicted to be moderate and **significant**.

10.449. For Gannet, the increase in distance to Fladen Ground was calculated to be 9.72km per foraging trip (Plot 10.42). This equates to an increase in additional daily energy expenditure of 3%, corresponding to a negligible magnitude and an impact of *minor* and *not significant*.

Table 10.34 Cumulative impacts of the Seagreen Project assessed based on the assessments of Project Alpha, Project Bravo and the Transmission Asset.

Impact	Project Alpha	Project Bravo	Transmission Asset	Cumulative	Justification
Construction					
Displacement through disturbance due to increased boat traffic	Eight service vessels and 1,760 trips	As Project Alpha	Assumed vessels and trips incorporated with Projects Alpha and Bravo	Simultaneous trips	These scenarios result in the maximum increase in boat traffic.
Indirect effects of construction on prey	One piling event	One piling event	Noise from cable laying	Simultaneous piling from Projects Alpha and Bravo	These scenarios are the maximum level of noise and duration which could impact on fish per site.
Operation					
Displacement	An area of 197.2km^2	An area of 193.7km^2	n/a	A combined area of 390.9km^2	These scenarios lead to the greatest potential for displacement
Barrier effects	See above for full extent of Project Alpha footprint	See above for full extent of Project Bravo footprint	n/a	See above for full extent of the Seagreen Project footprint	These scenarios lead to the greatest potential barrier to the movement of birds
Mortality through collision with turbine blades	75 x 7 MW WTGs	As Project Alpha	n/a	150 x 7MW WTGs but using the worst case rotation speed of 6 MW 126m rotor diameter WTGs	These scenarios lead to the highest predicted collision rates
Decommissioning					
Displacement through disturbance due to increased boat traffic	As construction above	As construction above	As construction above	As construction above	As construction above
Indirect effects of decommissioning on prey	Removal of all structures and cabling	Removal of all structures and cabling	Removal of cabling	Simultaneous removal	As construction above

Plot 10.41 Predicted least cost path flight line of Kittiwake from the Isle of May to a known foraging area in the presence of the Seagreen Project.



Mitigation

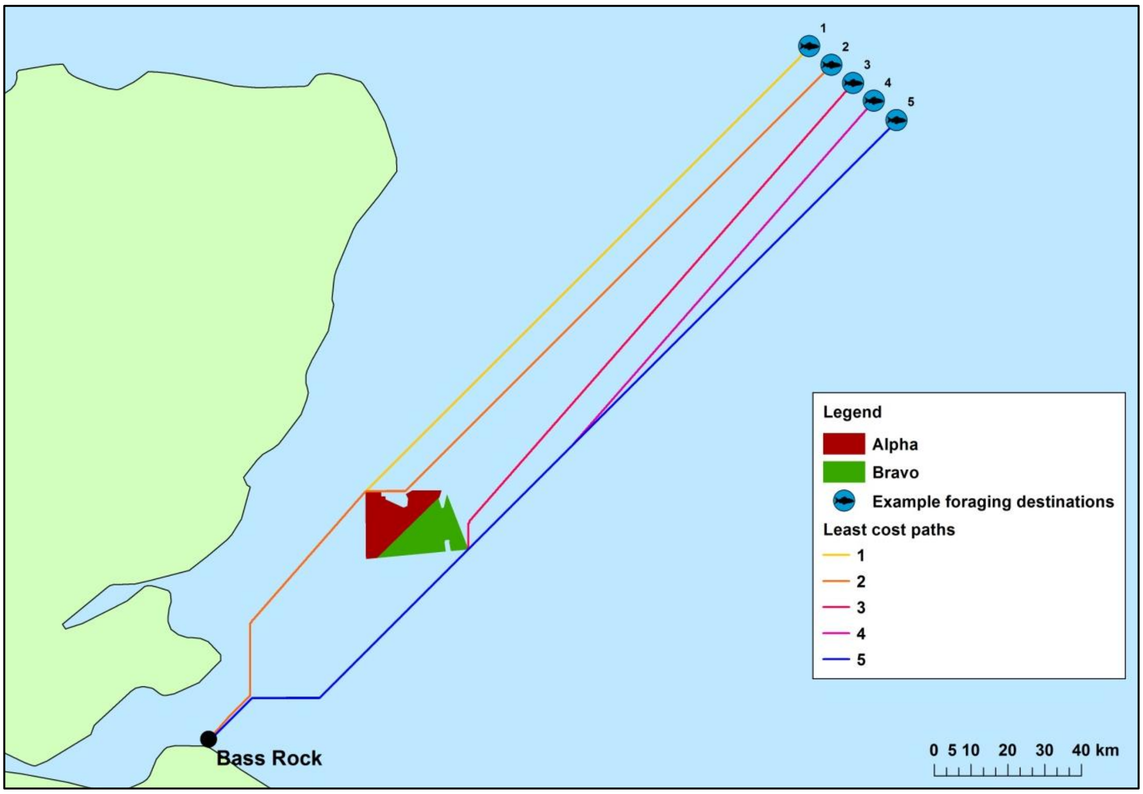
Mitigation
No mitigation is proposed at this stage.

10.450. Mitigation measures in relation to barrier effects for the Seagreen Project incorporating the foraging requirements of Kittiwake and also Gannet, are similar to those described for Project Alpha and Project Bravo (see 10.375 – 10.376). In a flight corridor of sufficient width along the boundary between Project Alpha and Project Bravo corresponding to the major flight line of Gannets from Bass Rock and Kittiwakes from the Isle of May, would potentially reduce any barrier effect and lower the risk of collision. However, it is not possible to establish this mitigation further until detailed design requirements are established for the project.

Residual Impact

10.451. An appropriate flight corridor has the potential to reduce the barrier effect of the Seagreen Project upon Kittiwake from the Isle of May to a level where *no impact* can be detected. The effect upon Gannet would also be reduced, although this was already of negligible significance.

Plot 10.42 Predicted least cost path flight lines of Gannet from Bass Rock to Fladen Ground in the presence of the Seagreen Project.



Mortality through collision with turbine blades

10.452. The same five sensitive receptor species assessed for both Project Alpha and Project Bravo are considered in a cumulative context for the Seagreen Project. Of the sensitive receptors, Gannet, Kittiwake, Lesser Black-backed Gull and Herring Gull are all of High sensitivity with Great Black-backed Gull of Medium sensitivity. The predicted mortality of each species per annum based on an avoidance rate of 98% from the Seagreen Project at different population scales is shown in Table 10.35.

10.453. A mortality rate of 1,665 Gannets of all ages per annum is predicted from the development of the Seagreen Project (Table 10.35). At this scale, 0.25% of the national population would be affected generating a low magnitude with a resultant moderate and **significant** impact. In relation to the adult population at designated colonies within foraging range of the Seagreen Project during the breeding season, the proportion affected increases to 1.3%, which is considered to be a high magnitude of effect thereby generating a *major* and *significant* impact.

10.454. In total, 1,299 Kittiwakes are predicted to collide with turbine blades within the Seagreen Project per annum (Table 10.35). Such a loss equates to 0.11% of the national population and therefore is of low magnitude with a resultant moderate and **significant** impact. A total of 0.68% of the adult population of designated colonies within foraging range of the Seagreen Project is predicted to be affected, which is an effect of medium magnitude producing an impact of *major* and *significant*.

10.455. The total predicted collision rate per annum for Lesser Black-backed Gull is 42 individuals (Table 10.35). At this rate of collision, 0.04% of the national population would be affected, which is of a negligible magnitude suggesting an impact of minor and **not significant**. In relation to the breeding population contained within designated colonies within foraging range of the Seagreen Project, 0.1% of adults are predicted to be affected, which gives a low magnitude thereby producing an impact of *moderate* and *significant*.

10.456. The mortality of Herring Gull from collision is predicted to be 124 birds per annum, (Table 10.35). The loss of 0.02% of the national population per annum is predicted to be of negligible magnitude giving an impact of minor and **not significant.** For the population contained within designated colonies within foraging range, the loss of 9 adults per annum representing 0.13% of the population is an effect of *low* magnitude and a resultant impact of *moderate* significance.

10.457. The predicted number of collisions for Great Black-backed Gull per annum at the Seagreen Project is 267 (Table 10.35), equating to the loss of 0.35% of the national population. The effect is of low magnitude resulting in a major and **significant** impact. With so few birds present within designated colonies, the predicted loss of just three adult birds in the breeding season equates to >5% of the population corresponding to an effect of high magnitude with a resultant *major* and *significant* impact (Table 10.35).

10.458. Confidence with the predicted outcomes for the Seagreen Project for the impact of mortality through collision with turbine blades is as described for Project Alpha and Project Bravo in isolation. In particular, the use of what could be argued to be a more realistic avoidance rate of 99% or more would reduce predicted collisions to <50% of the values reported, resulting in predicted impacts of moderate and not major significance.

Table 10.35 Predicted annual number of collisions of sensitive species at the Seagreen Project at an avoidance rate of 98%. Results are specified as individuals for the whole year, all individuals during the breeding season, and individuals within designated colonies and at specific component populations, including using the proportion of adults observed in surveys.

Species	Component population	Number of individuals	Predicted collisions per annum [1]	Proportion (%) [1]
Gannet	All	655,638 [2]	1,665	0.25
	Breeding season	437,092 [3]	1,456	0.33
	Designated colonies within mean max foraging range [4]	116,538 [5]	1,456 (1,415)	1.25 (1.21)
	Designated colonies within mean max foraging range +1SD [6]	151,822 [5]	1,444 (1,403)	0.95 (0.92)
	Forth Islands SPA	110,964 [5]	1,386 (1,347)	1.25 (1.21)
Kittiwake	All	1,139,676 [2]	1,299	0.11
	Breeding season	759,784 [3]	464	0.06
	Designated colonies within mean max foraging range [4]	38,840 [5]	277 (264)	0.71 (0.68)
	Designated colonies within mean max foraging range +1SD [6]	88,204 [5]	328 (312)	0.37 (0.35)
	Forth Islands SPA	5,370 [7]	39 (37)	0.73 (0.69)
	Fowlsheugh SPA	28,386 [5]	203 (193)	0.72 (0.68)
Lesser Black-backed Gull	All	336,222 [2] (120,000 [8])	42	0.01 (0.04)
	Breeding season	224,148 [3]	34	0.02
	Designated colonies within mean max foraging range [4,9]	6,916 [5]	10 (7)	0.14 (0.10)
	Forth Islands SPA	6,914 [5]	10 (7)	0.14 (0.10)
Herring Gull	All	417,927 [2] (730,000 [8])	124	0.03 (0.02)
	Breeding season	278,618 [3]	41	0.01
	Designated colonies within mean max foraging range [4]	6,850 [5]	13 (9)	0.19 (0.13)
	Designated colonies within mean max foraging range +1SD [6]	18,196 [5]	16 (11)	0.09 (0.06)
	Forth Islands SPA	6,422 [7]	12 (9)	0.19 (0.14)
	Fowlsheugh SPA	428 [5]	0.8 (0.5)	0.19 (0.12)
Great Black-backed Gull	All	51,480 [2] (76,000 [8])	267	0.52 (0.35)
	Breeding season	34,320 [3]	22	0.06
	Designated colonies within mean max foraging range [10]	56 [5]	4 (3)	7.14 (5.36)

1. For designated populations, and where data is available, values in parentheses refer to adult birds only. 2. Breeding population of UK from Baker *et al.* (2006) x 1.5 to estimate for non-breeding birds. 3. Breeding population of UK from Baker *et al.* (2006). 4. All SPA and SSSI designated colonies within mean maximum foraging range. 5. Latest breeding population as specified in Baseline Technical Report (Volume III Appendix F1). 6. All SPA and SSSI designated colonies within mean maximum foraging range +1SD. 7. Latest breeding population within mean maximum foraging range from as specified in Baseline Technical Report (Volume III Appendix F1). 8. Wintering population from Musgrove *et al.* (2011). 9. There are no additional designated colonies between mean maximum and mean maximum +1SD foraging ranges. 10. SSSI designated colonies within mean maximum foraging range. There are no SPA designated colonies within this range.

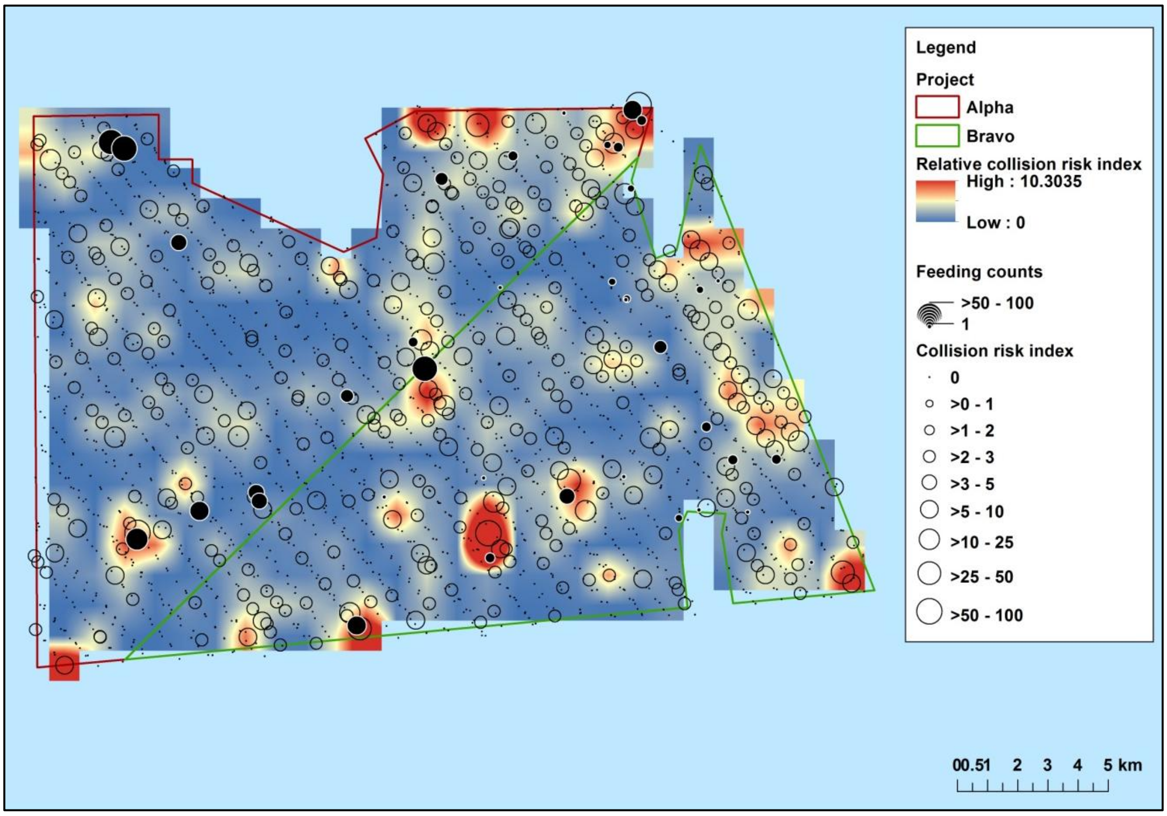
Mitigation

Mitigation
No mitigation is proposed at this stage.

10.459. The mitigation suggested within the Project Alpha and Project Bravo is applicable to the Seagreen Project, i.e. following detailed design, careful positioning of the WTGs to avoid 'collision hotspots' and thus reduce the potential impact of collision with turbine blades.

10.460. Examples of spatial collision risk modelling for Kittiwake and Gannet are provided in Plots 10.43 and 10.44 respectively. A hotspot of Kittiwake collision risk in the northeast corner of the Seagreen Project extending beyond the boundary of the site corresponds to the core foraging patch revealed by tracking of birds at both Fowlsheugh (Plot 10.31) and the Isle of May (Plot 10.32). The risk associated with this hotspot and for any bird attempting to reach it but without being displaced, would be mitigated by the provision of a flight corridor between the boundary between Project Alpha and Project Bravo.

Plot 10.43 Spatial representation of relative collision risk of Kittiwake in the Seagreen Project. Scaled open circles show collision risk index at each snapshot with scaled closed circles showing feeding aggregations recorded in line transect.



10.461. Avoidance of hotspots, especially those contained within Project Alpha, would reduce the collision risk of Gannet (Plot 10.44). However, the reasons for these hotspots is not specifically clear as they do not link closely to feeding aggregations, and could simply result from the recording of larger groups of birds in commuting flight. As such, a flight corridor of the same alignment as such for Kittiwake may be sufficient to dramatically reduce collision risk.

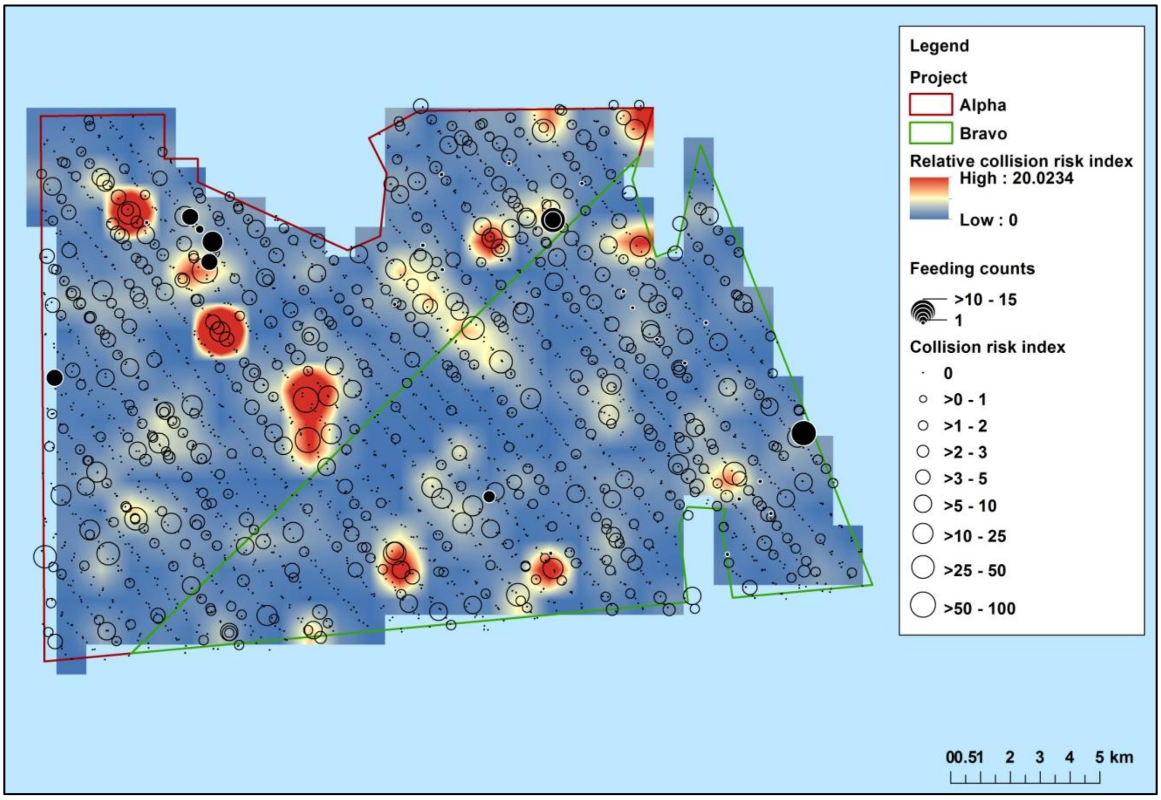
Residual Impact

10.462. Further analysis incorporating the actual location of the WTGs would be required to calculate the residual impact of the mitigation measures described.

Displacement through disturbance due to increased boat traffic (decommissioning)

10.463. The impact of displacement through disturbance due to increased boat traffic for the Seagreen Project is considered the same as both individual projects, i.e. of negligible magnitude. This results in a minor and **not significant** impact for Gannet, Kittiwake, Lesser Black-backed Gull, Herring Gull, Guillemot, Razorbill and Puffin and a negligible and **not significant** impact on Great Black-backed Gull and Arctic Tern.

Plot 10.44 Spatial representation of relative collision risk of Gannet in the Seagreen Project. Scaled open circles show collision risk index at each snapshot with scaled closed circles showing feeding aggregations recorded in line transect.



Mitigation

Mitigation
Mitigation measures are as described for the impact of displacement through disturbance due to increased boat traffic in Project Alpha and Project Bravo, with application of a code of conduct for vessel operators to help reduce disturbance of foraging and resting seabirds.

Residual Impact

10.464. Good practice by vessel operators would potentially reduce but not entirely eliminate any effect upon individual seabirds.

Indirect effects of decommissioning on prey

10.465. The cumulative impact of the Seagreen Project of indirect effects of decommissioning on prey, is not considered to be greater than the individual impacts of Project Alpha or Project Bravo. Therefore an impact of negligible magnitude, results in an impact of minor and **not significant** for Kittiwake, Guillemot, Razorbill and Puffin (high sensitivity), and an impact of negligible and **not significant** for Arctic Tern (medium sensitivity).

The Seagreen Project Cumulative Impact with Other Schemes

10.466. A total of 17 projects were identified by Seagreen, which required consideration cumulatively with the Seagreen Project. These included other OWFs in the planning stages i.e. Neart na Gaoithe and those at the concept stage, i.e. Hywind Demonstration site near Aberdeen. Onshore developments, such as Grangemouth Renewable Energy Plant, were also included.

10.467. Further searches based on the foraging ranges of the sensitive receptors described in this ES chapter were also undertaken. A brief description of the projects considered is provided in Table 10.36.

Table 10.36 Summary details of Project Alpha and Project Bravo considered in a cumulative context with Project Seagreen.

Development	Distance to Alpha (km)	Distance to Bravo (km)	Status	Brief description of the project
Phase 1 Seagreen Met Mast	2.1	11.15	Decision pending	Meteorological mast to provide wind speed monitoring for performance evaluation and planning of works at the site. Please note this met mast is in addition to the three met masts included within Project Alpha and Project Bravo.
Inch Cape Offshore Wind farm	8.67	11.17	EIA ongoing	Site lies in the outer Firth of Tay region. The site is located approximately 15 - 22km to the east of the Angus coastline in Scotland. The site is expected to consist of around 180 wind turbines covering an area of about 150km^2 with an estimated installed capacity of 1,000 MW.
Neart na Gaoithe Offshore Wind Farm	27.42	29.67	ES submitted	Wind farm is located some 15km off the Fife coast and covers an area of approximately 100km^2. The project has the potential to generate 420 MW of renewable energy.
GlaxoSmithKline Tidal Energy	32.41	40.82	Unknown	Proposed siting of 15 tidal turbines under the South Esk bridge (Potential output 0.5 MW).
Coastal Improvement Works at the Mouth of the Barry Burn	47.86	50.78	Approved	Coastal improvement works at the Mouth of the Barry Burn comprising replacement of existing tank blocks and sand dunes with rock armour and provision of retaining wall. Planning app no. 11/ 01177/ FULL
Hywind Demonstration Site (Hywind II)	48.15	49.72	-	No details available

Development	Distance to Alpha (km)	Distance to Bravo (km)	Status	Brief description of the project
European Offshore Wind Development Centre	58.24	64.54	Decision pending	The project consists of up to 11 wind turbines with a maximum power generation of up to 100 MW. The wind turbines would export the electricity onshore to a new substation and then to the National Grid. Additional onshore facilities may include a deployment centre with a research and development centre.
Dundee Renewable Energy Plant	62.16	65.08	Decision pending	Proposed 120 MW biomass energy plant.
V&A Museum planning app. No. 11/ 00309/ PAN	63.54	66.45	Proposal of Application Notice	Extension to the Riverside Walk and construction of the V & A museum building.
Methil Wind Turbine Demonstration Project.	76.76	79.4	Consented	One 6 MW offshore wind turbine. Planning app no. 10/ 02713/ NEA
Rosyth Renewable Energy Plant	107.03	109.66	Decision pending	Proposed 120 MW biomass energy plant.
Forth Replacement Crossing	107.16	109.76	Consented	New road bridge over Firth of Forth.
Rosyth International Container Terminal Project	108.51	111.16	Decision pending	The works proposed comprise the formation of a berthing pocket (including quay walls, sea walls and revetment works), provision of dolphin structures and associated walkways, repair and maintenance of an existing jetty, dredging of a turning circle and approach channel in the Forth, provision of lighting columns, an electrical substation, a truck holding area, weighbridge, craneage, container stack areas, buildings, and subsidiary works.
Grangemouth Renewable Energy Plant	122.73	125.46	Decision pending	Proposed 120 MW biomass energy plant.
Moray Firth Offshore Wind Farm R3 Zone	165.31	173.74	ES submission later this year	The development zone is located on the Smith Bank in the Moray Firth and covers an area of 522.15km^2. It is located 22.2km from the coast and may have an installed capacity in the order of 1300 MW which would require approximately 260 turbines.
Beatrice Offshore Wind Farm	176.32	185.55	ES submitted	It is approximately 13.5km from the Caithness coastline and will cover an approximate area of 131.5km^2. Installed capacity of up to 1,000 MW
Seagreen Phases 2 and 3	0?	0?	Scoping	It is anticipated that there will be five wind farms in the two areas. Phase 2 is planned to comprise three wind farms, Seagreen Charlie,

Development	Distance to Alpha (km)	Distance to Bravo (km)	Status	Brief description of the project
				Seagreen Delta and Seagreen Echo with Phase 3 having two wind farms, Seagreen Foxtrot and Seagreen Golf. The total installed capacity is anticipated to be up to 2.6 GW.
Teesside Offshore Wind Farm			Construction	Foundation installation finished 7th June 2012. Project capacity= 62.1 MW, 27 turbines, SWT-2.3-93 Siemens (2.3 MW turbines), rotor diam = 93 m.
NOVA project demonstrator			Concept	Concept/ early planning. Project capacity = 10 MW, 1 turbine, Aerogenerator X (Wind Power Limited).
NOVA project			Concept	Concept/ early planning. Project capacity 1,000 MW, 100 turbines, Aerogenerator X (Wind Power Limited), 10 MW turbines.
Blyth			Operational	Operational Dec 2000. Project capacity = 4 MW, 2 turbines, V66-2MW (Vestas), rotor diam = 66 m.
Blyth NaREC Offshore wind Demonstration Project			ES submitted	ES submitted to MMO 28th March 2012. Project capacity = 99.9 MW, 15 turbines, 5- 7 MW turbines.
Westernmost Rough			Consented	Planning-consent authorised 29th Nov 2011. Project capacity = 240 MW, 34-80 turbines.
Humber Gateway			Construction	Onshore construction starts Dec 2011. Project Capacity = 219 MW, 73 turbines, V112-3.0 MW Offshore (Vestas), rotor diam = 112 m.

10.468. Cumulative effects with schemes other than OWFs is considered to be unlikely, as OWFs have the potential to generate specific impacts upon birds, notably collision with moving blades. Collision is arguably the most important long-term effect of any of the typical effects of anthropogenic development projects.

10.469. Nevertheless, cumulative impacts of other projects have been considered for the same seven potential impacts generated by Project Alpha, Project Bravo and the Transmission Asset Project considered in detail above. Table 10.37 lists the projects under consideration for each of the potential impacts. Phases 2 and 3 of the Firth of Forth Round 3 Zone have been excluded from assessment (as agreed with Marine Scotland), as the data has yet to be analysed in a form that can be used to determine any cumulative impacts.

Table 10.37 Outline of potential cumulative effects in the different phases of development and the schemes considered most likely to interact in a cumulative context with the Seagreen Project.

Phase	Effect	Schemes
Construction	Displacement through disturbance due to increased boat traffic	Inch Cape OWF, Neart na Gaoithe OWF, GlaxoSmithKline Tidal Energy, Hywind Demonstration Site (Hywind II), Forth Replacement Crossing and Rosyth International Container Terminal Project
	Indirect effects of construction on prey	Inch Cape OWF and Neart na Gaoithe OWF
Operation	Mortality through collision with turbine blades	Inch Cape OWF, Neart na Gaoithe OWF, Methil Wind Turbine Demonstration project, Hywind Demonstration Site and European Offshore Wind Development Centre.
	Displacement	Inch Cape OWF and Neart na Gaoithe OWF
	Barrier effects	Inch Cape OWF and Neart na Gaoithe OWF
Decommissioning	Displacement through disturbance due to increased boat traffic	Inch Cape OWF, Neart na Gaoithe OWF, GlaxoSmithKline Tidal Energy, Hywind Demonstration Site (Hywind II), Forth Replacement Crossing and Rosyth International Container Terminal Project
	Indirect effects of decommissioning on prey	Inch Cape OWF and Neart na Gaoithe OWF

Displacement through disturbance due to increased boat traffic during construction

10.470. The projects considered for this potential impact are listed in Table 10.37. With the lack of published information on these projects, the negligible magnitude of the effect of displacement through disturbance due to increased boat traffic described in the Seagreen Project has been applied to all projects. This also included Neart na Gaoithe which was submitted in the final stages of preparation of this ES and thus it was not possible to incorporate the actual findings of the assessment.

10.471. The effect from all the projects can be considered as temporary and short term. However, the scenario where all projects are under construction simultaneously, the overall impact will be synergistic for shared receptors. Species of more offshore environments such as Gannet, Kittiwake and Puffin are unlikely to be shared between all projects (e.g. Forth Replacement Crossing and Rosyth International Container Terminal Project).

10.472. Nonetheless, a cumulative effect of low magnitude is suggested. For the sensitive receptors classified as being of High sensitivity, including Gannet, Kittiwake, Lesser Black-backed Gull, Herring Gull, Guillemot, Razorbill and Puffin the resultant impact is predicted to be moderate and **significant**. For Medium sensitivity Great Black-backed Gull and Arctic Tern any impact is suggested to be of minor and **not significant**.

Indirect effects of construction on prey

10.473. Insufficient detail was available to determine the exact nature of construction activity and construction noise of all projects. However, the non wind-farm sites were assumed to have a relatively low additional cumulative impact as a result of the construction methods likely to be used (i.e. without piling) and their location in areas that were unimportant to the sensitive ornithological receptors at the Seagreen Project. Moreover, the impact of the combined wind farm sites was sufficiently large to mean that additional impact from other non-wind farms was largely irrelevant.

10.474. The worst case scenario for indirect effects on prey is for all OWFs to be constructed contiguously using piled jackets for WTGs substructure/ foundations. This would result in an impact over at least five years, considered to be long term in duration. No detailed description of likely piling scenarios of Inch Cape was available at the time of writing and there was insufficient time to incorporate information from Neart na Gaoithe submitted in the final stages of preparation of this ES. Given the likely similarity of the construction methods, a similar scale of impact upon the same sensitive fish receptors including sandeels and especially clupeids was assumed. The equivalent scale of impact range predicted for Project Alpha and Project Bravo in isolation is assumed for both Inch Cape and Neart na Gaoithe (Plot 10.45).

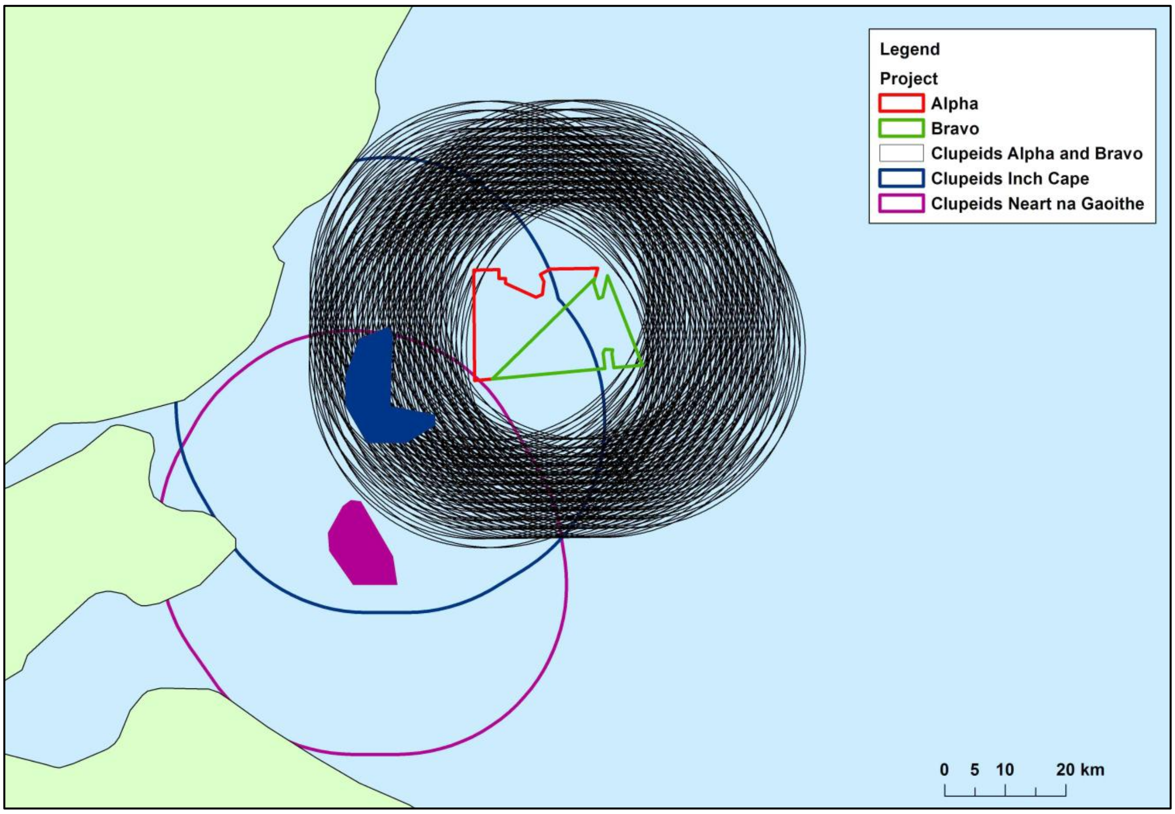
10.475. The area affected by the STW sites extends the potential impact of the Seagreen Project into the inshore areas entirely encompassing the core foraging areas of many species such as Kittiwake (see Plots 10.31 & 10.32), Guillemot (see Plot 10.30), Razorbill (see Plot 10.31) and Puffin at Fowlsheugh, Forth Islands and St Abbs to Fast Castle SPAs. The relative impact of the STW sites as they are closer to the colonies and impinge more directly on core foraging areas is of greater magnitude than the Seagreen Project.

10.476. The effect of the STW sites is thus expected to at least increase the magnitude of effect by at least one category compared to that predicted for Project Alpha (see 10.309, 10.310 and 10.312 above) and Project Bravo (see 10.316 above) in isolation and combined as The Seagreen Project (see 10.437 above). Thus, for the breeding species, the magnitude of effect would be medium for high sensitivity Guillemot, Razorbill and Puffin resulting in an impact of major and **significant**. For high sensitivity breeding Kittiwake, the dependence on sandeels results in a lower magnitude of effect, raised to low for all sites in a cumulative context. The significance of the impact upon Kittiwake would be moderate and **significant**.

10.477. For medium sensitivity Arctic Tern on passage, the medium magnitude of effect would result in an impact of moderate and **significant** significance in a cumulative context.

10.478. The significance of the impacts predicted is in keeping with the extended duration of construction and extent of effect that could result in long-term disruption of food webs with the potential to impact on several internationally important sites of nature conservation containing multiple breeding species. Indeed, other breeding species such as Gannet, Herring Gull, Lesser Black-backed Gull and Great Black-backed Gull may also be subject to impacts, although these are unlikely to be of significance as a result of the catholic nature of their diets and wide-ranging behaviour of Gannet, meaning that it would be able to exploit areas outside of the Firth of Forth unaffected by development.

Plot 10.45 Predicted maximum impact range (28km) of a strong avoidance reaction to piling of Herring /Sprat in relation to each WTG in the indicative layout at the Seagreen Project and for the site at Neart na Gaoithe and Inch Cape.



Displacement

10.479. The same four sensitive receptors considered for the impact of displacement from the Seagreen Project have been considered in a cumulative context with other projects. These are Kittiwake, Guillemot, Razorbill and Puffin all species breeding in internationally important numbers in the area. However, assessment is only conducted for the STW sites of Inch Cape and Neart na Gaoithe (see Table 10.37) as a result of the likely broad similarity of the distribution and abundance of the sensitive receptors at all sites, with individuals birds likely to originate from the same, generally designated, colonies.

10.480. Displacement of birds from the Seagreen Project has been assessed as described in the cumulative displacement section above (i.e. based on peak population estimates of the sensitive receptors and using respective avoidance distances to provide the proportion of the footprint from which birds are displaced). Such information is not yet available for Inch Cape and there was insufficient time to incorporate information from Neart na Gaoithe submitted during the final preparations of this ES. Moreover, a number of differences to the analysis have been required due to the available data (NIRAS, 2012). For example, in relation to peak populations, only DISTANCE corrected birds on the water have been used for Neart na Gaoithe. Numbers were also reduced by 50% for the analysis undertaken by NIRAS (2012) and thus peak numbers from both sites have been doubled here to restore true peak populations representing all birds (also see Mortality through collision with turbine blades below). In both cases, with no understanding of prospective WTG layout and spacing, 100% displacement from what are relatively small sites has been assumed.

10.481. As with the cumulative CRM (see below) only numbers of birds in the breeding season were supplied for Inch Cape and Neart na Gaoithe and therefore cumulative displacement has been assessed against the populations at designated colonies.

10.482. The results of the calculations based on displacement resulting in 1% mortality are shown in Table 10.38.

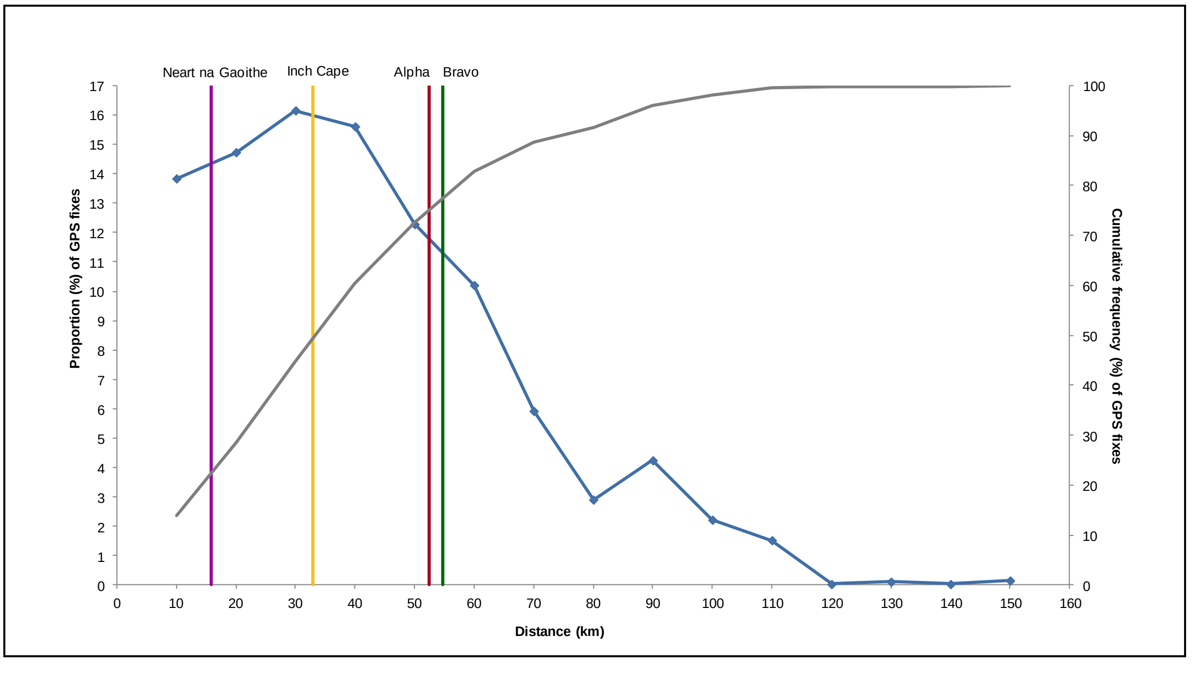
Table 10.38 Number and proportion of birds affected by 1% mortality due to displacement from sites considered cumulatively during the breeding season and at designated colonies within foraging distance.

Species	Project Seagreen	Inch Cape	Neart na Gaoithe	Total	Proportion (%)
Kittiwake	6	13	7	26	0.067
Guillemot	30	48	13	90	0.069
Razorbill	5	29	3	37	0.807
Puffin	10	21	15	46	0.023

10.483. The proportion of Kittiwake affected by cumulative displacement, 0.07%, implies a magnitude of negligible impact. However, cumulatively, the combined footprints of the sites equate to >10% of the foraging ranges from Fowlsheugh, Isle of May and St. Abb's Head, and thus the magnitude of impact based on habitat lost would be considered as medium (Table 10.9), with an overall impact of major and **significant**.

10.484. The relative contribution of each site to cumulative risk is neatly illustrated by tracking studies. At the Isle of May the proximity of Neart na Gaoithe and the fact that it falls within core foraging habitat (Plot 10.32) means that this site accumulates a lot of use by Kittiwake (Plot 10.46). The relative contribution of Neart na Gaoithe to displacement of Kittiwakes from the Isle of May is thus likely to be relatively high.

Plot 10.46 Proportion and cumulative frequency of GPS fixes of Kittiwakes from the Isle of May in 2010 in relation to distance from the colony and all wind farms in the Firth of Forth.

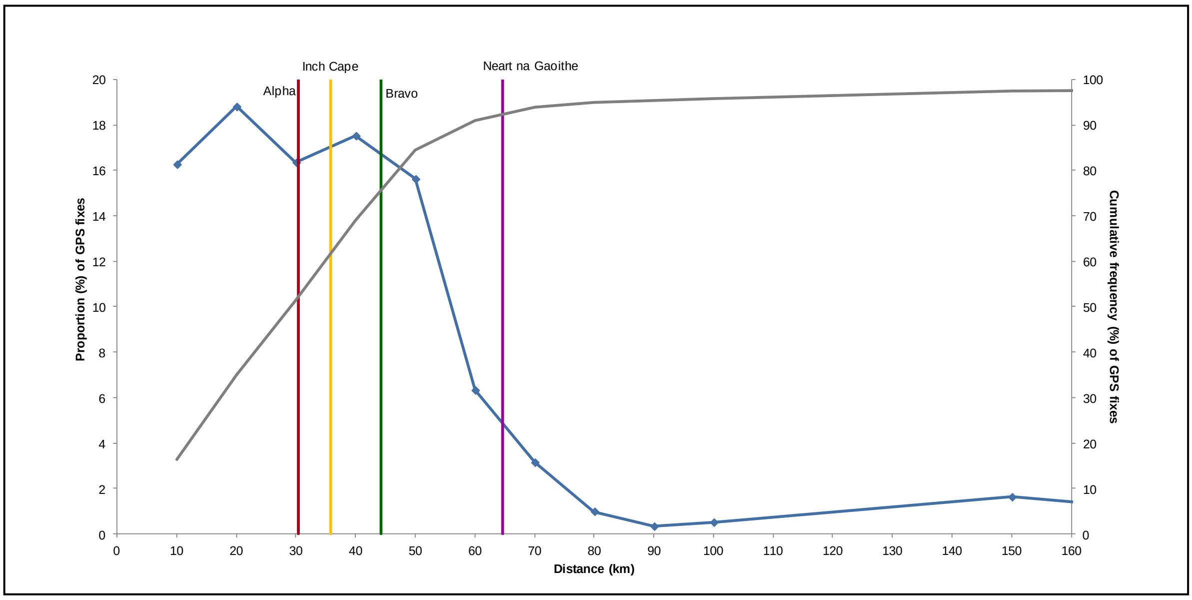


10.485. Conversely, Neart na Gaoithe makes relatively little impact upon birds from Fowlsheugh, with only ~20% of use occurring at equivalent distance from the colony (Plot 10.47).

10.486. The magnitude of impact of displacement on designated colonies during the breeding season derived from the developed matrix for Guillemot is considered to be negligible. However, the proportion of foraging habitat lost from the Isle of May (based on mean maximum range from Thaxter *et al.*, 2012) exceeds 5% and is therefore considered of medium magnitude. Tracking studies from the Isle of May (Daunt *et al.*, 2011a,b,c,d) showed that core foraging areas (70% density contours) fell within distance of any developments, a compromise magnitude of low is considered more appropriate. Therefore the cumulative impact of displacement on Guillemot from designated colonies is moderate and **significant**.

10.487. The proportion of Razorbill affected by the impact of cumulative displacement was high at 0.8%, equivalent to a magnitude of medium impact. With 14% of the foraging range of Razorbill potentially lost to the cumulative footprints of the OWFs and tracking studies revealing core foraging grounds within both STW sites in some years (Daunt *et al.*, 2011c.) this would support an impact of medium magnitude. Therefore the overall cumulative impact of displacement of Razorbill from designated colonies would be major and **significant**.

Plot 10.47 Proportion and cumulative frequency of GPS fixes of Kittiwakes from the Fowlsheugh in 2011 in relation to distance from the colony and all wind farms in the Firth of Forth.



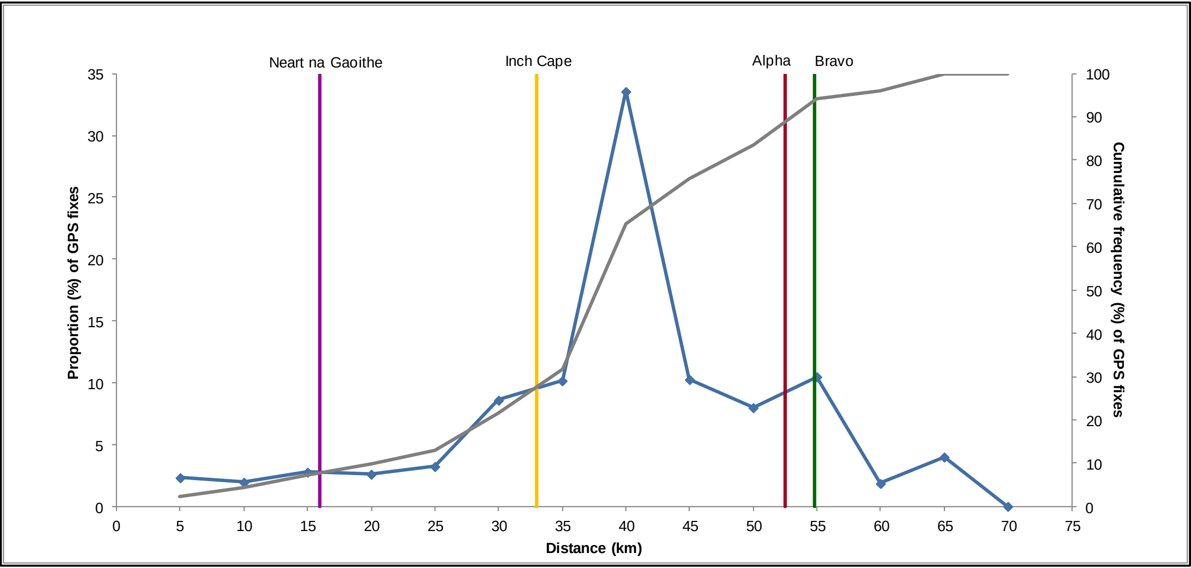
10.488. The predicted magnitude of the impact of displacement for Puffin from designated colonies within foraging distance using the population matrix is negligible. Based on habitat lost due to the developments, 4% would be lost from the Isle of May colony, implying an impact of low magnitude. Whilst tracking studies were unable to use kernel densities to develop key foraging areas, <35% of all GPS fixes were recorded prior to the boundary of Inch Cape (i.e. including Neart na Gaoithe) (Plot 10.48), a medium magnitude could be more appropriate. However, without the weight of tracking studies of the other sensitive receptors, a low magnitude is suggested. Therefore, the overall cumulative impact of displacement of the designated Puffin colonies is moderate and **significant**.

Barrier effects

10.489. The barrier effects of the two STW sites, Inch Cape and Neart na Gaoithe have been analysed in a cumulative context with the Seagreen Project in relation to Kittiwake from the Isle of May and Gannet from Bass Rock.

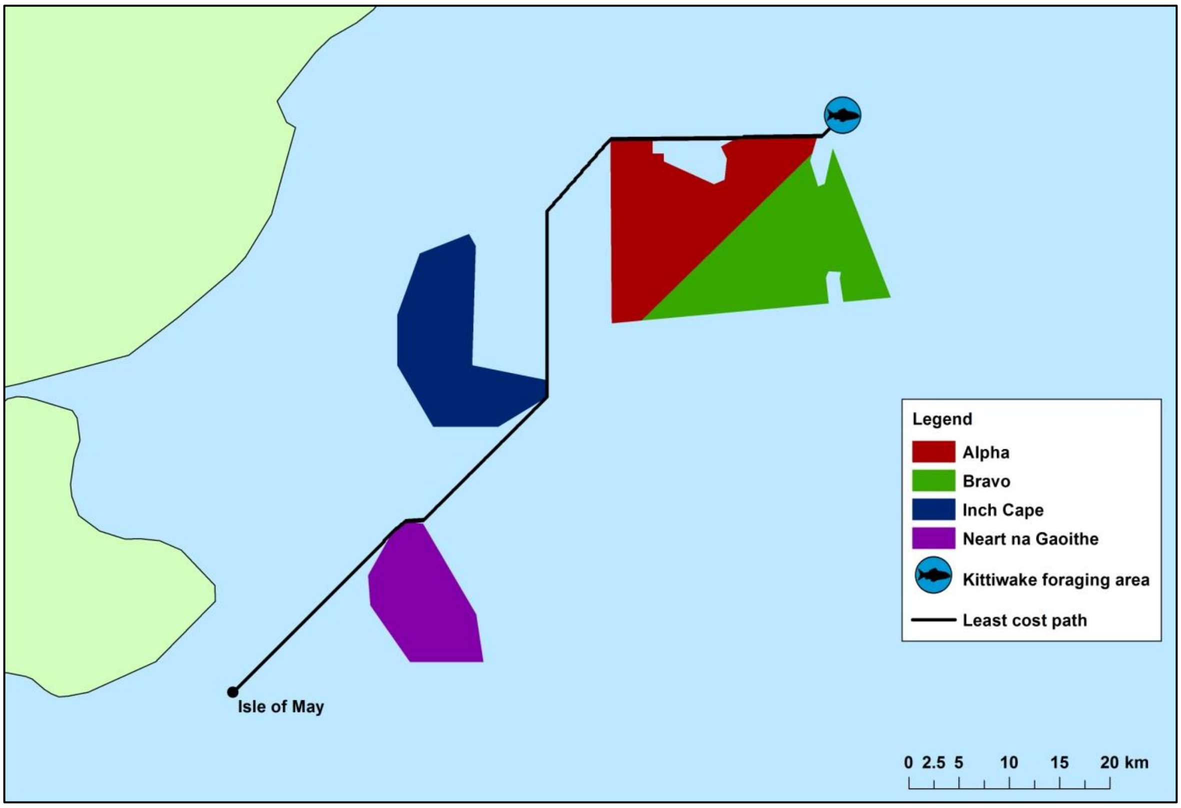
10.490. The development of the two STW sites with the Seagreen Project would add 22.7km to each foraging trip undertaken by Kittiwake to the foraging area just beyond the northeastern corner of the Seagreen Project (Plot 10.49). According to the relationship extrapolated from Masden *et al.* (2010) where additional energy cost = (0.0015 x additional distance [m]) - 0.08 (Plot 10.35) the additional daily energy expenditure of such a trip would be 34% and thus of low magnitude (see Table 10.16). The overall impact of barrier effects of all Projects on Kittiwake is thus predicted to be moderate and **significant**.

Plot 10.48 Proportion and cumulative frequency of GPS fixes of Puffin from the Isle of May in 2010 in relation to distance from the colony and all wind farms in the Firth of Forth.

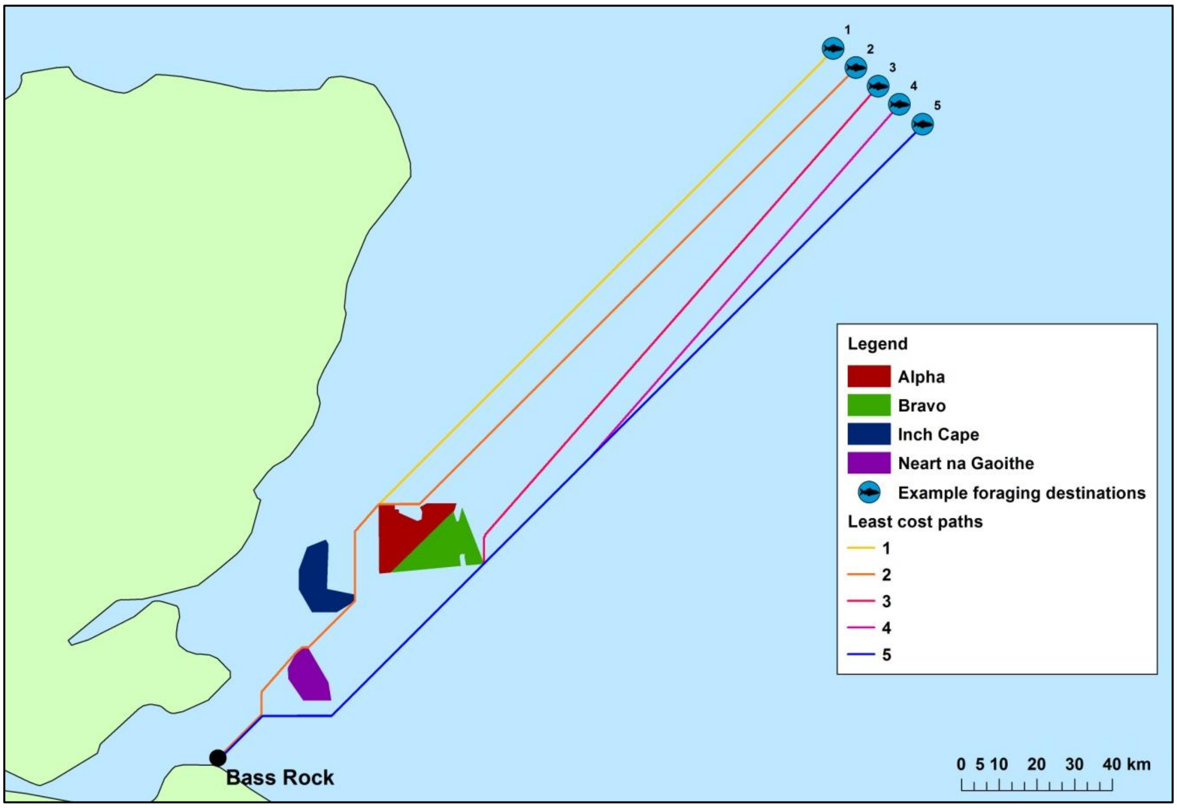


10.491. For Gannet, an additional 10.6km per foraging trip in the presence of the Seagreen Project and the STW sites was estimated from least cost path analysis (Plot 10.50). An increase of 3.3% to daily energy expenditure is predicted from the relationship derived by Masden *et al.* (2010). The resultant effect is of *negligible* magnitude (see Table 10.16), with an impact of *minor* significance. The STW sites thus have no additional impact relative to that of the Seagreen Project.

Plot 10.49 Predicted least cost path flight line of Kittiwake from the Isle of May to a known foraging area in the presence of the Seagreen Project and then STW sites.



Plot 10.50 Predicted least cost path flight lines of Gannet from Bass Rock to Fladen Ground in the presence of the Seagreen Project.



Mortality through collision with turbine blades

10.492. The same five species considered for the potential impact of collision at the Seagreen Project, namely Gannet, Kittiwake, Lesser Black-backed Gull, Herring Gull and Great Black-backed Gull, are also considered in a cumulative context with other projects.

10.493. Based on the foraging range of Gannet derived from Thaxter *et al*,. *(*2012), there is also scope for the Seagreen Project to be assessed cumulatively with Beatrice OWF and the Moray Firth Round 3 Zone in the north and Westernmost Rough OWF in the south. However, Hamer *et al*,. (2011) assert that most, if not all, Gannet observed during the breeding season will originate from Bass Rock.

10.494. Using the average foraging range from the colony and also the location of key foraging sites and thus the direction of flights, the number of schemes was reduced to five (see Table 10.36). From these projects, no quantitative data for any of the five species could be sourced for the European Offshore Wind Development Centre and the Hywind Demonstration Site.

10.495. The majority of Kittiwakes recorded at the Seagreen Project during the breeding season are thought to originate from Fowlsheugh and the Isle of May. The foraging area for the birds from the Isle of May is therefore very likely to include the offshore wind farms at Inch Cape and Neart na Gaoithe, and the Methil Wind Turbine Demonstration Project, while the foraging area for the birds from Fowlsheugh is very likely to include Inch Cape, the Hywind Demonstration Site and the European Offshore Wind Development Centre. As no data has been sourced for the latter two schemes, these have not been included in the analysis.

10.496. The Forth Islands SPA contains the majority of Lesser Black-backed Gulls in the area. In addition to the Seagreen Project, birds from the Forth colonies are likely to reach Inch Cape, Neart na Gaoithe and the Methil Wind Turbine Demonstration Project. Lesser Black-backed Gull was not identified as a target species within the Methil Offshore Demonstration Wind Turbine Environmental Statement (Arcus, 2010) and at the time of writing no data was available for the species from the two STW sites.

10.497. For Herring Gull, the designated colonies at Fowlsheugh SPA and within the Forth Islands SPA are key to this assessment. In addition to the Seagreen Project, birds from Fowlsheugh are likely to reach Inch Cape, the Hywind Demonstration Site and the European Offshore Wind Development Centre, while those from the Forth Islands are likely to reach the offshore wind farms at Inch Cape and Neart na Gaoithe, and the Methil Wind Turbine Demonstration Project. The Methil scheme has not however been included in this assessment, as Herring Gull was not recorded as a target species (Arcus, 2010).

10.498. Great Black-backed Gulls recorded at the Seagreen Project during the breeding season could originate from the SSSI-designated colonies at Fowlsheugh, Forth Islands and the Isle of May. Hence, these three colonies have also been considered in a cumulative context at the offshore wind farms at Inch Cape and Neart na Gaoithe, the Methil Wind Turbine Demonstration Project, the Hywind Demonstration Site and the European Offshore Wind Development Centre. As with Herring Gull, Great Black-backed Gulls were not recorded as target species and thus no CRM was undertaken for the Methil project (Arcus, 2010) and no data was available from Inch Cape or Neart na Gaoithe.

10.499. To at least allow some assessment of likely collision risk from both Inch Cape and Neart na Gaoithe, the data compiled by NIRAS (2012) was used. Data was only available for the breeding season and no assessment can be conducted for outside this period. Further data is now available for Neart na Gaoithe, but as this was submitted during the final stages of the preparation of this ES, this could not be incorporated here. Nevertheless, preliminary appraisal suggests that the procedure of eliminating non-breeding birds by halving collision values was adopted in the ES for Neart na Gaoithe in the same manner as indicated in the treatment by NIRAS (2012) following instruction by Marine Scotland. This procedure is not considered to be valid and for comparative purposes and to allow assessment of the impact upon birds of all ages in the first instance, the collision risk estimates presented by NIRAS (2012) for both Neart na Gaoithe and Inch Cape have been restored by scaling by a factor of two. Assessment of impacts upon adults only may follow by adjustment by the appropriate factor for the proportion of adults as adopted for Project Alpha and Project Bravo (see 10.165 above), although this was not undertaken here in the absence of specific information.

10.500. The total collision rate for each wind farm site was partitioned so that the impact on designated colonies within foraging range could be assessed. This partitioning was achieved by calculating the collision rate only for that proportion of birds that were assumed to be associated with the designated breeding colonies within foraging range to the exclusion of non-designated breeding colonies. The results from the CRM are shown in Table 10.39.

10.501. The predicted cumulative number of collisions for the Gannet population from designated colonies was 4,967 individuals per annum based on mean maximum foraging distance (Table 10.39), equivalent to 4.3% of the population. A combination of a high magnitude of effect and the high sensitivity of Gannet predicts a cumulative impact of major and **significant**.

10.502. For Kittiwake, the predicted cumulative number of collisions per annum for the population from designated colonies was 423 based on mean maximum foraging distance (Table 10.39), equivalent to 1.1% of the population and thus equivalent to a high magnitude of effect. The cumulative impact of mortality through collision with turbine blades is therefore considered to be major and **significant**.

10.503. As no further data on Lesser Black-backed Gull was available for CRM, the potential impact of collision with turbine blades was as presented for the Seagreen Project, i.e. low magnitude and a cumulative effect of moderate and **significant**.

10.504. The predicted cumulative number of collisions per annum for the Herring Gull population from designated colonies was 43 (Table 10.39), equivalent to 0.6% of the expressed population. The cumulative effect is thus assessed as of medium magnitude resulting in an impact of major and **significant** upon Herring Gull. Using the mean maximum (+1 SD), the magnitude is reduced to low (0.1 to 0.5% - Table 10.39), and the overall impact drops to being moderate and **significant**.

10.505. As no further data on Great Black-backed Gull was available for CRM, the potential impact of mortality through collision with turbine blades was as presented for the Seagreen Project, i.e. with a high magnitude of effect and a cumulative impact of major and **significant**.

Displacement through disturbance due to increased boat traffic (decommissioning)

10.506. As construction above.

Indirect effects of decommissioning on prey

10.507. The impact of decommissioning on prey is unlikely to increase from a negligible magnitude regardless of whether the decommissioning of the Seagreen Project and Inch Cape and Neart na Gaoithe occur simultaneously or sequentially. Therefore, the impact of minor and **not significant** is derived for the Seagreen Project sensitive receptors is adopted.

Transmission Asset Project

10.508. The Transmission Asset Project was assessed cumulatively with Project Alpha and Project Bravo, as well as with other wind farm sites including Inch Cape and Neart na Gaoithe, oil and gas activities and aggregate dredging projects. No cumulative effects of greater than negligible magnitude were identified.

Table 10.39 Predicted annual number of collisions of sensitive receptors at the Seagreen Project and other wind farm sites at an avoidance rate of 98%. Results are specified as all individuals within designated breeding colonies during the breeding season.

Species	Component Population	Number of individuals[1]	Predicted collisions per annum					Proportion (%)
			The Seagreen Project	Inch Cape[2]	Neart na Gaoithe[3]	Methil[4]	Total	
Gannet	Designated colonies within mean max foraging range [5]	116,538	1,456	2,654	857	< 1	4,967	4.26
	Designated colonies within mean max foraging range +1SD [6]	151,822	1,444	2,633	850	< 1	4,927	3.25
Kittiwake	Designated colonies within mean max foraging range [4]	38,840	277	110	36	< 1	423	1.09
	Designated colonies within mean max foraging range +1SD [6]	88,204	328	130	42	< 1	500	0.57
Lesser Black-backed Gull	Designated colonies within mean max foraging range [4, 7]	6,916	10	-	-	-	10	0.14
Herring Gull	Designated colonies within mean max foraging range [4]	6,850	13	23	7	-	43	0.63
	Designated colonies within mean max foraging range +1SD [6]	18,196	16	29	9	-	54	0.30
Great Black-backed Gull	Designated colonies within mean max foraging range [8]	56	4	-	-	-	4	7.14

1 Latest breeding population from Baseline Technical Report (Volume III Appendix F1) 2Data from NIRAS (2012). Values stated in the NIRAS report have been (i) x2 to account for all birds rather than just adults and (ii) scaled to account for change in worst case scenario from a site with maximum capacity of 1,029 MW to one with maximum capacity of 1300 MW. 3 Data from NIRAS (2012). 4 Data from Arcus (2010). 5 All SPA and SSSI designated colonies within mean maximum foraging range. 6 All SPA and SSSI designated colonies within mean maximum foraging range +1SD. 7 There are no additional designated colonies between mean maximum and mean maximum +1SD foraging ranges. 8 SSSI designated colonies within mean maximum foraging range. There are no SPA designated colonies within this range.

ENVIRONMENTAL STATEMENT LINKAGES

10.509. The key relationship between other physical and/or environmental parameters and ornithology considered within this ES chapter is with the ecology of fish considered in Chapter 12: Natural Fish and Shellfish Resource) (Table 10.40).

Table 10.40 Environmental Statement Linkages.

Inter-relationship	Relevant section	Linked chapter
The potential impact on fish, a key prey resource, through the Seagreen Project on seabird populations.	Indirect effects of construction on prey Indirect effects of decommissioning on prey	Chapter 12: Natural Fish and Shellfish Resource

OUTLINE MONITORING

Project Alpha

10.510. A monitoring programme should be developed in consultation with JNCC and SNH. The programme should be largely comparable with the baseline programme to allow direct comparison of density and population size.

10.511. The continuation of tracking studies (Daunt *et al.*, 2011a,b,c) is also recommended, both upon the same species and sites but also including other species/sites such as Razorbill and Guillemot from Fowlsheugh if at all possible. Otherwise, Kittiwake remains a priority species for investigation.

10.512. Specific studies to assess species-specific avoidance rates and any impact of collision should also be considered.

10.513. Further studies to elucidate the relationship between sensitive species and available habitat would also be beneficial to better assess the implications of habitat loss.

10.514. During construction, particular attention should be given to assessing any changes in the distribution and abundance of fish and birds. The complete lack of understanding of these aspects handicaps meaningful assessment.

Project Bravo

10.515. The same scope of monitoring programme described for Project Alpha is recommended for Project Bravo.

Transmission Asset Project

Infrastructure within the Project Alpha and Project Bravo site boundaries

10.516. No specific monitoring of the Transmission Asset Project infrastructure within Projects Alpha and Bravo is considered to be required.

Export Cable Route (ECR) Corridor

10.517. No monitoring of the ECR corridor is considered to be required.

SUMMARY

10.518. A summary of the potential impacts discussed in detail in the impact assessment sections of this chapter is tabulated for both Project Alpha (Table 10.41) and Project Bravo (Table 10.42) below.

Summary of Project Alpha Impacts

Table 10.41 Summary of impacts resulting from Project Alpha.

Description of Effect	Sensitive Receptor	Scale	Effect	Potential Mitigation Measures	Residual Impact
Construction Phase					
Displacement through disturbance due to increased boat traffic	Gannet Kittiwake Lesser Black-backed Gull Herring Gull Guillemot Razorbill Puffin Great Black-backed Gull Arctic Tern	n/ a	Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Negligible and **not significant** Negligible and **not significant**	Good practice guidelines in relation to ornithology	No change in impact
Indirect effects of construction on prey	Kittiwake Guillemot Razorbill Puffin Arctic Tern	n/ a	Minor and **not significant** Moderate and **significant** Moderate and **significant** Moderate and **significant** Minor and **not significant**	Good practice guidelines in relation to potential impacts upon sensitive fish (e.g. soft start)	No change in impact
Operation Phase					
Mortality through collision with turbine blades	Gannet Kittiwake Lesser Black-backed Gull Herring Gull Great Black-backed Gull	National Regional National Regional National Regional National Regional National Regional	Moderate and **significant** Moderate and **significant** Minor and **not significant** Moderate and **significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Moderate and **significant** Minor and **not significant** Major and **significant**	Placement of turbines to avoid high density areas as highlighted by CRM 'hotspot' mapping	There is potential to reduce the overall impact from mortality form collision with turbines.

Description of Effect	Sensitive Receptor	Scale	Effect	Potential Mitigation Measures	Residual Impact
Displacement	Kittiwake	National	Minor and **not significant**	Placement of turbines at locations suggested as 'least' important based on habitat studies	Potential to have no residual impact.
		Regional	Minor and **not significant**		
	Guillemot	National	Minor and **not significant**		
		Regional	Minor and **not significant**		
	Razorbill	National	Minor and **not significant**		
		Regional	Minor and **not significant**		
	Puffin	National	Minor and **not significant**		
		Regional	Minor and **not significant**		
Barrier effects	Gannet Kittiwake Guillemot Razorbill Puffin	n/ a	Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant**	Placement of turbines to allow flight corridors to key foraging sites.	n/ a
Decommissioning Phase					
Displacement through disturbance due to increased boat traffic	Gannet Kittiwake Lesser Black-backed Gull Herring Gull Guillemot Razorbill Puffin Great Black-backed Gull Arctic Tern	n/ a	Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Negligible and **not significant** Negligible and **not significant**	Good practice guidelines in relation to ornithology	No change in impact
Indirect effects of decommissioning on prey	Gannet Kittiwake Guillemot Razorbill Puffin Arctic Tern	n/ a	Negligible and **not significant** Negligible and **not significant** Negligible and **not significant** Negligible and **not significant** Negligible and **not significant** Negligible and **not significant** Negligible and **not significant**	n/ a	n/ a

Summary of Project Bravo Impacts

Table 10.42 Summary of impacts resulting from Project Bravo.

Description of Effect	Sensitive Receptor	Scale	Effect	Potential Mitigation Measures	Residual Impact
Construction Phase					
Displacement through disturbance due to increased boat traffic	Gannet Kittiwake Lesser Black-backed Gull Herring Gull Guillemot Razorbill Puffin Great Black-backed Gull Arctic Tern	n/ a	Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Negligible and **not significant** Negligible and **not significant**	Good practice guidelines in relation to ornithology	No change in impact
Indirect effects of construction on prey	Kittiwake Guillemot Razorbill Puffin Arctic Tern	n/ a	Minor and **not significant** Moderate and **significant** Moderate and **significant** Moderate and **significant** Minor and **not significant**	Good practice guidelines in relation to potential impacts upon sensitive fish (e.g. soft start)	No change in impact
Operation Phase					
Mortality through collision with turbine blades	Gannet Kittiwake Lesser Black-backed Gull Herring Gull Great Black-backed Gull	National Regional National Regional National Regional National Regional National Regional	Moderate and **significant** Moderate and **significant** Minor and **not significant** Moderate and **significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Major and **not significant**	Placement of turbines to avoid high density areas as highlighted by CRM 'hotspot' mapping	There is potential to reduce the overall impact from mortality form collision with turbines.
Displacement	Kittiwake Guillemot Razorbill Puffin	National Regional National Regional National Regional National Regional	Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant**	Placement of turbines at locations suggested as 'least' important based on habitat studies	Potential to have no residual impact.

Description of Effect	Sensitive Receptor	Scale	Effect	Potential Mitigation Measures	Residual Impact
Barrier effects	Gannet Kittiwake Guillemot Razorbill Puffin	n/ a	Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant**	Placement of turbines to allow flight corridors to key foraging sites.	n/ a
Decommissioning Phase					
Displacement through disturbance due to increased boat traffic	Gannet Kittiwake Lesser Black-backed Gull Herring Gull Guillemot Razorbill Puffin Great Black-backed Gull Arctic Tern	n/ a	Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Minor and **not significant** Negligible and **not significant** Negligible and **not significant**	Good practice guidelines in relation to ornithology	No change in impact
Indirect effects of decommissioning on prey	Gannet Kittiwake Guillemot Razorbill Puffin Arctic Tern	n/ a	Negligible and **not significant** Negligible and **not significant** Negligible and **not significant** Negligible and **not significant** Negligible and **not significant** Negligible and **not significant** Negligible and **not significant**	n/ a	n/ a

Summary of Transmission Asset Project impacts

10.519. This assessment and the associated Technical Appendix (Appendix F2) for the Transmission Asset Project considered the potential impacts on ornithological receptors that may arise from development of the transmission assets. Key sensitive receptors were identified from site-specific survey data and from wider reference material. No significant or adverse impacts were identified.

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